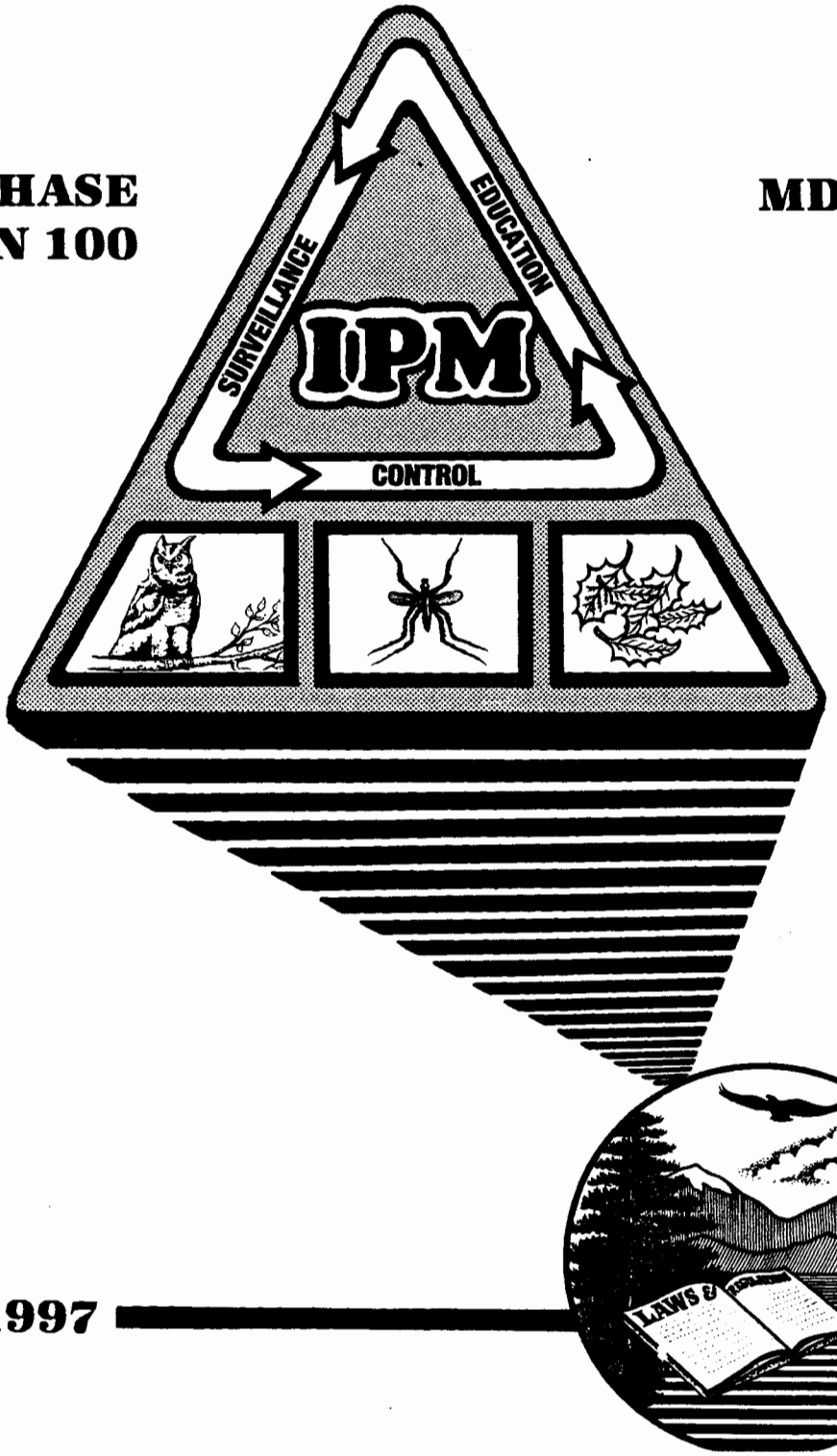
UNITED STATES ARMY
ACADEMY OF HEALTH SCIENCES

DEPARTMENT OF DEFENSE PEST MANAGEMENT COURSE

CORE PHASE
EDITION 100

MD 0141



1997

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the U.S. Army Medical Department Center and School and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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ADMINISTRATION

For comments or questions regarding enrollment, student records, or shipment of subcourses, contact the Nonresident Instruction Branch: **DSN 471-5877**; toll-free **1 (800) 344-2380**; COMMANDER, U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL, NONRESIDENT INSTRUCTION BRANCH, ATTN: MCCS-HSN (BLDG 4191), 2105 11TH STREET, FORT SAM HOUSTON, TX 78234-6199.

CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

USE OF PROPRIETARY NAMES

The initial letters of the names of some products are capitalized in this subcourse. Such names are proprietary names; that is, brand names or trademarks. Proprietary names have been used only to make this subcourse a more effective learning aid. The use of any name, proprietary or otherwise, should not be interpreted as endorsement, deprecation, or criticism of a product. Nor should such use be considered to interpret the validity of proprietary rights in a name, whether it is registered or not.

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US ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
DEPARTMENT OF DEFENSE PEST MANAGEMENT COURSE
FORT SAM HOUSTON, TEXAS 78234-6122

STUDENT INSTRUCTIONS

1. **Application for Enrollment.** Your application for enrollment in the Department of Defense Pest Management Course (DoDPMC) correspondence course has been accepted.

2. **Course Design.** The DoDPMC is designed as an independent study program to qualify you for the DoD Pesticide Applicators Certification under the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, and the DoD 4150.7-P, Plan for the Certification of Pesticide Applicators. The course is not intended as a comprehensive program of study for pest management, but as qualifying instruction for certification.

3. **DoDPMC Components.** The DoDPMC is made up of 3 subcourses:

   MD0141, CORE Phase.
   MD0142, Phase I.
   MD0143, Phase II.

   To complete the course, you will not be required to read outside material. However, referenced materials may be of assistance to you in understanding difficult subject matter.

4. **Components of this Subcourse.**

   This subcourse consists of 16 lessons. The lessons are:

   Lesson 1, Pesticide Laws and Regulations.

   Lesson 2, Reports and Records.

   Lesson 3, Alternatives to Pesticides.

   Lesson 4, Installation Pest Management Plans.

   Lesson 5, Introduction to Arthropods.

   Lesson 6, Animal Damage Control.

   Lesson 7, Evaluation of Pest Control Operations.

   Lesson 8, Pesticides and the Environment

   Lesson 9, Pesticide Toxicology.

   Lesson 10, Pesticide Classification and Formulation.

   Lesson 11, The Pesticide Label.

   Lesson 12, Safe Handling of Pesticides.

Lesson 13, Pesticide Application Techniques.

Lesson 14, Pesticide Application Equipment.

Lesson 15, Equipment and Calibration Procedures.

Lesson 16, Pesticide Calculations.

5. **Credit Awarded.** Successful completion of this subcourse is a prerequisite for all EPA pest control categories offered by the DoD.

6. **Lesson Materials Furnished.** Lesson materials provided include this booklet. Solutions to lesson exercises are contained in Appendix F of this booklet.

7. **Procedures for Subcourse Completion.**

   Step 1. Complete the subcourse lesson by lesson, reading each lesson and completing and checking the lesson exercises.

   Step 2. Notify the Certifying Official that you are ready to take the final examination.

   Step 3. The Certifying Official will notify you that the final examination has arrived. You and that individual will coordinate a time for you to take the closed-book examination.

   Step 4. At the designated time and place, you will take the closed-book final examination.

   Step 5. Your examination sheet will be graded. Within 2 to 3 weeks, you will be notified that you have passed or failed the examination.

NOTE
QUALIFYING FOR THE
DoD PESTICIDE APPLICATOR'S CERTIFICATION

◆ Pass the CORE exam + PHASE I exam	=	DoD Pest Control Categories 2, 3, 3a, 5, 6, and 6a.
◆ Pass the CORE exam + PHASE II exam	=	DoD Pest Control Categories 7, 7a, and 8.
◆ Pass the CORE exam + PHASE I exam) + PHASE II exam)	=	DoD Pest Control Categories 2, 3, 3a, 5, 6, 6a, 7, 7a, and 8.

8. **Examination Validity.** In order to maintain the validity of these examinations, you are not to discuss the contents of the examinations, give answers to anyone else, or reproduce the examination without permission.

9. **Course Completion/Certification.** In order to complete the course and qualify for DoD Pesticide Applicators Certification, you must achieve a minimum grade of 70 percent on each examination. You have 12 months from the time you are enrolled to complete the course. Should you require additional time, you may be granted an **extension of time** (a waiver) by contacting the Nonresident Instruction Branch, Fort Sam Houston, Texas.

10. **Examination Failures.** Examination failures will result in one retest if you score between 50 and 69 percent. You will be given up to 90 days to retake that examination. A score of less than 50 percent or failure to retest on the CORE examination will disqualify you for the DoD Pesticide Applicators Certification by correspondence. A score less than 50 percent or failure of a retest on Phase I or Phase II examinations will disqualify you for the DoD Pesticide Applicators Certification by correspondence in the DoD pest control categories covered in the failed Phase.

11. **Student Comment Sheet.** Be sure to provide us with your suggestions by filling out the Student Comment Sheet (found at the back of this booklet) and returning this sheet with the examinations. In this way, you will help us improve the quality of this course.

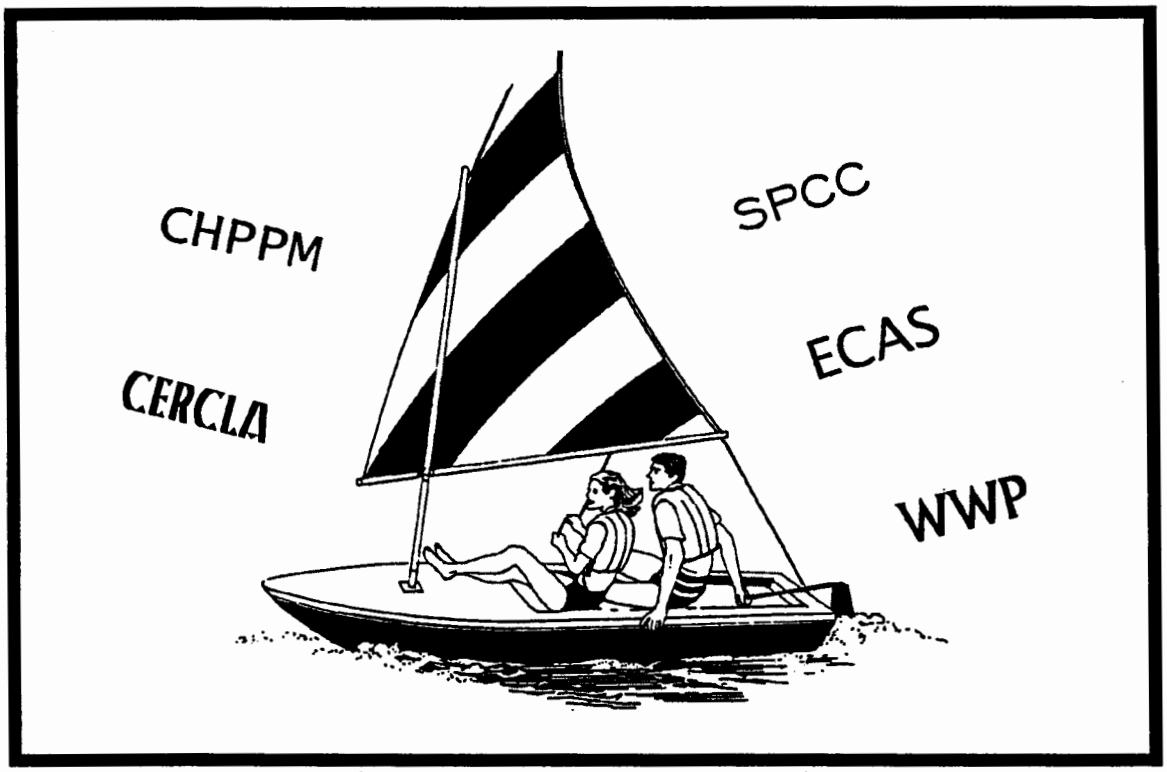
12. **Study Suggestions.**

The following suggestions may be helpful to you in completing this subcourse:

- Read and study each lesson carefully.
- Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.
- After completing each set of lesson exercises, compare your answers with those on the solution sheet which follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.
- As you successfully complete each lesson of a subcourse, go on to the next. When you have completed all of the lessons, notify Certifying Official that you are ready to take the final examination of that subcourse. Alternatively, you may wait until you have completed all of the lessons in all subcourses, and request all three final examination at the same time.

ACRONYMS

For your convenience, acronyms are located at the back of this subcourse in Appendix E.



If we have missed any acronyms that you think should be included in this booklet, please let us know.

LESSON ASSIGNMENT	
LESSON 1	Pesticide Laws and Regulations.
LESSON ASSIGNMENT	Paragraphs 1-1 through 1-41.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to discuss the Federal, DoD, and Department of the Army laws and regulations that govern pest management on property controlled by the Army.
SPECIFIC LESSON OBJECTIVES	After completing this lesson, you should be able to:
	1-1. Identify the Army regulations that apply to the Directorate of Public Works, Pest Management Program, IAW AR 420-76.
	1-2. Identify the pest management actions that are legal although not specified on the pesticide label, IAW the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.
	1-3. Identify the legal effect of the following Federal laws: ◆ FIFRA . . Federal Insecticide, Fungicide, and Rodenticide Act. ◆ CWA . . . Clean Water Act. ◆ CERCLA Comprehensive Environmental Response, Compensation, and Liability Act. ◆ ESA . . . Endangered Species Act. ◆ OSHA . . Occupational Safety and Health Act.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson.

LESSON 1

PESTICIDE LAWS AND REGULATIONS

Section I. GENERAL INFORMATION

1-1. INTRODUCTION

The benefits of pesticides are well known, and it is doubtful that anyone would dispute this. However, in recent years, there has been a growing awareness of the hazards as well as the benefits of pesticide use. This has led to changes in the laws and regulations dealing with pesticides. Although pesticides have been subject to some degree of Federal control since 1910, the relatively insignificant use of pesticides prior to the 1940s made regulating pesticides a low priority. Regulation was primarily concerned with protecting consumers from ineffective products or deceptive labeling. World War II stimulated development and use of pesticides, and the agricultural chemical industry was transformed into a major sector of our economy.

1-2. SEVEN APPLICABLE LAWS

There are numerous Federal and state laws which in some way pertain to pest and land management programs. It is impossible to thoroughly examine all of those laws that could possibly impact on you. This lesson examines seven different laws which are considered the most applicable.

	LAWS	YEAR
1.	Federal Insecticide, Fungicide, and Rodenticide Act	1947
2.	Clean Water Act	1977
3.	Comprehensive Environmental Response, Compensation, and Liability Act	1980
4.	Endangered Species Act	1973
5.	Occupational Safety and Health Act	1970
6.	Toxic Substances Control Act	1977
7.	National Environmental Policy Act	1970

Section II. FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA), 1947

1-3. GENERAL INFORMATION

In response to a growing need, Congress enacted the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1947. This act regulated the marketing of "economic" poisons and devices by means of a registration and labeling procedure for products subject to interstate commerce. This act is the basis for our present-day pesticide legislation. Congress has made several amendments to FIFRA since its enactment. As pesticide applicators, it is essential for you to have a working knowledge of these laws and regulations which impact on pest management operations.

1-4. PURPOSE

FIFRA and its amendments [Public Law (PL) 92-516 (1972); PL 94-51, 94-109, 94-140 (1975); PL 95-251, 95-396, and 5-369 (1978); PL 96-539 (1980); PL 98-201 (1983); PL 98-620 (1984); PL 100-202 (1987); PL 100-532 (1988); PL 101-624 (1990)] are designed to provide for registration of pesticides, post-market surveillance of pesticides, and pesticidal devices to ensure prevention of unreasonable adverse effects upon human health or the environment.

1-5. FIFRA AMENDED

In 1972, Congress amended the FIFRA to require stricter human health and environmental protection from pesticide abuse. There was no requirement for registration of pesticides until this time. The Environmental Protection Agency (EPA) was charged with issuing rules for reviewing all pesticides to ensure they meet the new safety requirements. Some 35,000 pesticides consisting of 1,400 basic ingredients are now sold in the US. The EPA is charged with the responsibility of protecting public health and the environment from the risks associated with exposure to pesticides. The EPA seeks cooperation with appropriate state and Federal agencies to fulfill this responsibility.

1-6. EPA CONTROL OVER PESTICIDES

The FIFRA attempts to give the EPA control over the thousands of chemical pesticides in use in the United States today. The act requires the registration of all pesticides with the EPA prior to their distribution and sale. The registration procedure is covered under Section 3(c) of the act. Each pesticide that is registered will be classified as either general use, restricted use, or both. Pesticides classified as restricted use may be applied only by or under the direct supervision of a certified applicator.

1-7. UNLAWFUL ACTS

Unlawful acts are covered extensively in Section 12 of the act. The two main actions that we are concerned with are found in subsection 2 where it states that (1) it is unlawful for any person to alter the label or (2) to use the pesticide in a manner not stated on the label. Exceptions to these two limitations include the following:

- The pesticide can be applied at any dosage, concentration, or frequency less than specified on the label unless the label specifically prohibits such application.
- The pesticide can be applied against a target pest not specified on the label if the crop, animal, or site is specified on the label.
- The pesticide can be applied, by any method, not prohibited by the label unless the label specifically states that the product can be applied only by the methods stated on the label.
- The pesticide can be mixed with a fertilizer when such mixture is not prohibited by labeling.

THE MESSAGE

☞ **Read THE LABEL very carefully!**

1-8. RECORDS FOR RESTRICTED USE PESTICIDES

Section 1491 requires certified applicators of restricted use pesticides to maintain records that contain the product name, amount, approximate date of application, and location of application of each such pesticide used for a two-year period after such use. These records shall be available to any Federal or state agency that deals with pesticide use or any health or environmental issue related to the use of pesticides on the request of such agency.

1-9. STANDARDS FOR CERTIFICATION OF PESTICIDE APPLICATORS

The EPA administrator shall prescribe standards for the certification of applicators of pesticides. Such standards shall provide that to be certified, an individual must be determined to be competent with respect to the use and handling of pesticides, or to the use and handling of the pesticide or class of pesticides covered by such individual certification. If any state desires to certify applicators of pesticides, they must submit a plan for such purpose to the EPA administrator for approval. (DoD applicators have to take written examinations to become certified.)

1-10. AUTHORITY GIVEN THE STATES

Section 24 of the act deals with the authority of the states. In general, a state may regulate the sale or use of any federally registered pesticide or device in the state, but only if and to the extent the regulation does not permit any sale or use prohibited by the act. In other words, states can make pesticide laws more restrictive, but not less restrictive than Federal pesticide laws.

1-11. EPA CONTROLS

Issue of restricted use pesticides must be controlled, as must disposal of all pesticides. The EPA may issue suspension or cancellation orders on a pesticide when it is determined to be a threat to human health or the environment. Penalties for violating this law involve fines and/or imprisonment.

1-12. ADMINISTRATIVE REVIEW AND SUSPENSION OF PESTICIDES

Section 6 deals with the administrative review and suspension of pesticides. A "notice of intent to cancel" represents EPA's finding that a pesticide generally causes unreasonable adverse effects upon the environment. It provides manufacturers and users of the pesticide and other interested persons the

chance to request courtroom-type hearings on the risks and benefits. Depending upon the complexity of the issues, these hearings may last a year or longer. The eventual outcome is a decision by the EPA administrator on the pesticide's registration. During cancellation hearings, the pesticide may continue to be sold.

1-13. SUSPENSION

"Suspension" may interrupt either the special review or cancellation process at any point. It is based upon a finding of imminent hazard posed by the pesticide.

- A brief public hearing may be held. (The exact length of the hearing may be determined by the EPA administrator.)
- The purpose of a suspension is to decide whether to allow continued sale of a pesticide during the time it would take to hold more in-depth cancellation hearings.

1-14. CANCELLED PESTICIDES

Cancelled pesticides include DDT, aldrin and dieldrin, some mercury pesticides, and certain predator poisons used primarily for coyote control.

- Chlordane and heptachlor have been suspended.
- The topical repellent 6-12 was voluntarily cancelled by its manufacturers in 1991.

1-15. ANNOUNCEMENT OF INTENT TO CANCEL OR INTENT TO SUSPEND

The announcement of the intent to cancel or an intent to suspend does not immediately affect pesticide use. The products may still be manufactured and used as outlined on the label. If the product is eventually cancelled or suspended, its use is then affected. The wording of the cancellation or suspension order is important here since only a few uses or all uses may be affected. Contact your command pest management consultant for clarification.

1-16. SPECIAL REVIEW

Special review means that use of a pesticide is subjected to intensive scientific review and public comment before a decision is made on whether to allow continued use or begin the process of removing the pesticide from the market.

a. Activation of Special Review Process. The special review process comes into play as follows:

- Manufacturers and users of the suspect pesticide and the general public are notified of the risk information and given 30 days to offer rebuttal evidence. The EPA may shorten this period to protect the public health.
- At the end of this period, EPA announces whether or not all risks have been rebutted.
- Depending upon the outcome of the risk/benefit analysis, the pesticide is proposed for approval, or EPA begins formal consultation with the US Department of Agriculture on the economic impact and sales. An independent scientific advisory panel reviews health and environmental effects information.
- After the USDA and scientific consultation, EPA must again decide whether to propose continued use of the pesticide or issue a "notice of intent to cancel" further production and sale. Regardless of which way the decision goes, the opportunity for a public hearing exists.

b. Advantage of a Special Review. The advantage of a special review is that it allows EPA to gather extensive scientific information about the effects of a chemical before determining whether prolonged, courtroom-type hearings on safety are necessary. Special reviews ensure that benefits and risks are given full consideration.

c. Special Review vs. Banning a Pesticide. A special review is not the same as banning a pesticide. Whether this occurs will depend upon the type of information received by the EPA and a judgement as to whether benefits appear to outweigh risks or vice versa.

d. Special Review Process. The special review process may last up to 180 days. During that time, the pesticide in question may continue to be sold. At the end of this period, the EPA will announce that the pesticide appears safe for continued use or that it may cause unreasonable adverse effects on the environment. If the latter occurs, additional investigation into benefits and risks begins. This includes consultation with scientific and economic experts and the opportunity for further comment from the general public.

1-17. CERTIFICATION STANDARDS FOR PESTICIDE APPLICATORS

PL 92-516, provides that the Administrator, EPA, "prescribe standards for certification of applicators of pesticides." Regulations that were promulgated to implement the act, require that Federal agency applicators of restricted use pesticides obtain appropriate state certification or participate in the Government Agency Plan (GAP). Because the Federal Working Group on Pest Management was terminated, EPA no longer certifies Federal employees under a single GAP. Instead, EPA changed the Federal employee certification from GAP to individual agency plans.

1-18. RESPONSIBILITY FOR DoD PROGRAM

Overall responsibility for policy development, implementation and surveillance of the DoD program rests with the Office of the Secretary of Defense (OSD) which is the lead agency. The Armed Forces Pest Management Board (AFPMB), chartered by the lead agency, reviews policy matters and proposes policy changes for the Department of Defense. DoD directive 4150.7-P, Plan for the Certification of Pesticide Applicators, is the Department of Defense's plan for certifying DoD pest applicators.

1-19. DoD INSTRUCTION

The Department of Defense (DoD) plan that pertains to the certification of personnel is DoD Instruction, Plan for the Certification of Applicators of Restricted Use Pesticides. This document applies to all employees applying any restricted use pesticide on DoD property. In the infrequent instances when DoD employees will be applying pesticides on non-DoD property, they will work under the supervision of appropriately certified state or Federal personnel.

NOTE: While DoD will not certify contractor personnel, the policies contained in this directive also apply to contractors for commercial pest control services as outlined.

Section III. CLEAN WATER ACT (CWA), 1947

1-20. THE OBJECTIVE

The Federal Water Pollution Control Act of 1972 was amended by the Clean Water Act of 1977. The objective of this act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

1-21. GOALS

The act sets forth goals to achieve the objective of the act. The following are just three of the seven goals set forth.

- It is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited.
- It is the national policy that a major research and demonstration effort be made to develop technology necessary to eliminate the discharge of pollutants into navigable waters, waters of the contiguous zone, and the oceans.

- It is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this act to be met through the control of both point and nonpoint sources of pollution.

1-22. SPILLS OF HAZARDOUS SUBSTANCES IN US WATERS

Section 311 describes the requirements and liabilities for spills of hazardous substances into US waters. If an accidental spill occurs, the spiller must bear the cost of the clean-up and must report the spill to the National Response Center (NRC) and to the state's authorities.

1-23. MILITARY INSTALLATIONS HAVE TWO PLANS

In order to comply with this requirement, all military installations are required to have two plans: a Spill Prevention Control and Counter Measures (SPCC) Plan and an Installation Spill Contingency Plan (ISCP). Pesticide spills and fires must be covered in these plans IAW AR 200-1. Examples of situations that would fall under this act would be:

- The spilling of a hazardous substance (pesticide, petroleum product, chemical) into any type of water source (lake, stream, underground, ditches, etc.).

- The washing or rinsing of equipment, containers, and material that have been used with a hazardous substance. The water that is so used must be properly collected and disposed of according to approved procedures for disposal of hazardous wastes.

NOTE: These are only two examples of situations which you may encounter in dealing with pesticide application. There can and will be other instances in which you may feel the situation is beyond your qualifications. Call for assistance or advice from the Installation Environmental Office or the Judge Advocate General (JAG).

Section IV. COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA or SUPERFUND), 1980

1-24. PURPOSE

The purpose of the act is to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites. This act only relates to pest control operations if a spill occurs or a pest control facility is designated as a cleanup site.

1-25. FUNDING

In the Department of Defense, the Defense Environmental Restoration Account (DERA) provides funding for designated prioritized cleanups. DERA funds are handled by the MACOM's who work with contractors and US Army Toxic and Hazardous Materials Agency (USATHAMA) to determine need for and extent of cleanup.

Section V. ENDANGERED SPECIES ACT (ESA), 1973

1-26. IDENTIFYING HABITATS

The US Fish and Wildlife Service is responsible for identifying the current habitat or range of each endangered species. For aquatic species, the restricted habitat often will include an additional zone around the body of water to

keep any drift, runoff, or leaching in the watershed from reaching the water. The US Fish and Wildlife Service is attempting to identify the habitats as accurately as possible so that limitations on pesticide use will only be in locations where such limitations are absolutely necessary. For this reason, limitations on pesticide use may apply on one property, while a similar adjoining property may not have these limitations.

1-27. USING A PESTICIDE THAT MIGHT CAUSE AN ENDANGERED SPECIES DEMISE

Under the Endangered Species Act, it is a Federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. Prior to making applications, the user must determine that endangered species are not located immediately adjacent to the site to be treated. If the user is in doubt whether or not endangered species may be affected, the user should contact the regional US Fish and Wildlife Service Office (Endangered Specialist) or personnel of the State Fish and Game Office.

1-28. AR 420-74

AR 420-74 provides general Department of the Army policies and guidance in the management of renewable natural resources. It states that installation commanders will assure that actions authorized, funded, or conducted do not jeopardize the continued existence of such endangered and threatened species.

1-29. THE INSTALLATION PLAN TO PROTECT ITS ENDANGERED/ THREATENED SPECIES

Each of the required pest and land management plans must address the installation's endangered and/or threatened species. Your management tactics can serve to protect or harm these species. Any installation Environmental Impact Statement (EIS) or Environmental Assessment (EA) will also address these species. Violation of the ESA is a Federal criminal offense and punishable as such.

1-30. KNOW THE LOCATION OF STATE AND FEDERAL ENDANGERED/ THREATENED SPECIES ON THE INSTALLATION

It is your responsibility to know where all state and Federal endangered and threatened species are on your installation. The impacts of pesticide use need to be studied and addressed in the EIS and EA prior to use.

Section VI. OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA), 1970

1-31. PURPOSE

The purpose of the act is to provide for safe and healthful working conditions for every working man and woman in the US. The act achieves this purpose by encouraging employers and employees to:

- Reduce the number of occupational safety and health hazards at their places of employment.
- Institute new and improve old programs for safe and healthful working conditions.
- Provide medical criteria, as practicable, to assure that no employee will suffer diminished health, functional capacity, or life expectancy as a result of his work experience.

1-32. REQUIREMENTS

Each employer must furnish to each of his employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees. Each employer must comply with occupational safety and health standards promulgated under this act. Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this act which are applicable to his own actions and conduct.

1-33. OSHA AND PEST CONTROL OPERATIONS

This act provides the requirement for pest control operations to provide pest control facilities which reduce pesticide exposure by a proper ventilation system and shower facilities. Safety equipment must also be provided in accordance with this act. It also provides for the occupational health monitoring of all pesticide applicators to detect increases in exposure.

Section VII. TOXIC SUBSTANCES CONTROL ACT (TSCA), 1977

1-34. TSCA AUTHORITY

This act authorizes the EPA to regulate chemicals used in commerce. This is done through the regulation of manufacture, distribution, use, and disposal. This act does not include chemical substances such as pesticides covered by FIFRA when manufactured, processed, or distributed in commerce for use as a pesticide.

1-35. PESTICIDES AS A WASTE BYPRODUCT

Pesticides may come under this act when they are declared a waste byproduct. The three types of pesticide wastes we are concerned with are:

- Old containers containing excess pesticide.
- Excess pesticide made up for application.
- The effluent from rinsing equipment when not used in the proscribed manner.

These types of waste may also come under the jurisdiction of the Resource Conservation and Recovery Act (RCRA). The Defense Reutilization and Marketing Office (DRMO) is responsible for the handling of excess pesticides turned in for disposal.

1-36. OTHER LAWS

It is your responsibility to know all the regulations which may impact on your pest management program. Only five public laws have been mentioned in this discussion; there are many more that may impact your program. You also need to know the state laws for your installation since the installation must comply with them.

Section VIII. REGULATIONS

1-37. ARMY REGULATION 200-5, PEST MANAGEMENT

This regulation reflects the current Army policies, procedures, and standards for pest management at installations under the Department of Army jurisdiction. The regulation applies to all installations and activities, to include nonappropriated fund activities, worldwide under control of the Department of the Army, the Army National Guard, and the US Army Reserve. It does not apply to civil works functions and facilities occupied by Army activities as tenants when real property control is under another military department or government agency.

a. Installation Commander Responsibilities. The installation commander is responsible for designating a pest management coordinator for all installation pest management activities and approving the pest management plan developed by the facilities engineers.

b. Installation Engineer Responsibilities. The installation's facilities engineers are responsible for:

- Preparing a pest management plan for all areas within the installation's responsibility.
- Supervising and directing pest management operations.
- Conducting preventive maintenance and surveillance inspections.
- Ensuring that operating personnel receive adequate training to achieve the required pest management certification.
- Providing on-the-job training of new pest control operators.
- Obtaining and maintaining adequate supplies of pesticides and pesticide dispersal equipment.
- Assuring that all pest management operations are done safely.
- Performing all record keeping and reporting requirements.

c. Preventive Medicine Medical Authority Responsibilities. The medical authority, Preventive Medicine Service, serving the installation is responsible for:

- Conducting surveillance of medically important pests. The results of these surveys are to be reported to the Installation Pest Management Coordinator (IPMC).
- Obtaining identification and susceptibility status of pest to pesticides as necessary.
- Establishing health and personnel safety criteria for pesticide operations.

d. Responsibilities of the Installation Pest Management Coordinator. The IPMC will be a pest management supervisor or pest management professional who will develop and monitor the installation pest management annual work plan and coordinate with all activities conducting pest surveillance or applying pesticides to ensure all applicable information is recorded and reported.

e. Certified Pesticide Applicators. The minimum number of certified pesticide applicators required to perform pest management operations on an installation is based on the defined workload. Pesticide applicators will be certified in all categories of pest control required for their assigned function or work under the direct supervision of a certified supervisor responsible for that function. Pesticide applicators will use pesticides only in accordance with EPA approved label directions.

f. Installation Pest Management Programs. Installation pest management programs, utilizing the most efficient organization will be established and maintained as a part of the installation real property maintenance program.

- Professional pest management personnel or a certified pesticide applicator will manage the program.
- An installation pest management plan will be written and submitted to the MACOM Pest Management Consultant (PMC) for approval.
- Each installation will review and update its pest management plan annually.
- The use of preventive or scheduled periodic pesticide treatments is prohibited except in special circumstances.
- Pest management programs will use all aspects of Integrated Pest Management (IPM) to minimize the impact on the environment and to ensure effective preventive and corrective measures.

g. Training and Certification of Pesticide Applicators. All pesticide applicators who determine the effectiveness or selection and application of pesticides on Army real property must receive FIFRA training and certification.

- All pesticide applicators must complete and pass the core phase training and then the appropriate training for each category certification they need.

- In accordance with the Status of Forces Agreement (SOFA), personnel must also be trained to apply pesticides according to the host country's laws when they differ from US laws. The most restrictive law for use and disposition of pesticides will be followed.

h. Command Cooperation. In accordance with AR 700-93 and AR 40-12, all command levels will cooperate fully with Federal agencies responsible for quarantine of plants and animals with agricultural and public health significance. Installations will procure pesticides, equipment, and other materials

i. Aerial Pesticide Application. Aerial pesticide application is done IAW AR 40-574. Before an aerial application is conducted, an environmental assessment must be prepared (See AR 200-2). Training for aerial application is conducted by the Air Force and is a separate certification category.

j. Review and Approval of Proposed Pest Management Contracts. MACOM Pest Management Consultants review and approve technical provisions of all proposed pest management contracts. State certification is accepted for competency. Contract pest control will be monitored and evaluated by Quality Assurance Evaluators (QAEs) having DoD QAE pest management training.

k. Self-Help Pest Control Programs. Installations will establish self-help pest control programs for use by military housing occupants.

- Residents of military housing will be advised of the self-help program, the need to practice good sanitation, and their responsibility for the control of minor pest problems.

- Installation pest management personnel will conduct pest control in military housing only when the pest threatens government property, the occupants' health, or the occupants have been unable to control the pest following a concentrated effort.

l. Use and Disposition of Pesticides. The use and disposition of pesticides will be in accordance with this regulation, AR 40-5, AR 200-2, and appropriate Federal, state, and local regulations. In overseas areas, host country law, SOFA, or US regulations will be followed, whichever is the most stringent.

m. Mixture and Storage of Pesticides. Pesticides will be mixed and stored only in facilities that conform to the workplace safety and health requirements in 29CFR1910.106, national, state, and local fire codes, and guidance provided by medical authorities and 40CFR165.10. Design and construction criteria guidance and recommendations for these facilities provided in MIL-HDBK 1028/8A will be implemented to the maximum extent possible.

n. Pesticide Applicator Self Protection. Approved masks, respirators, rubber gloves, rubber boots, and protective clothing will be provided at government expense and used, as required, during the mixing and application of pesticides.

- Pesticide-contaminated protective clothing will not be laundered at home, but will be laundered at government expense.

o. Pesticide Disposal. No pesticide, pesticide container, or pesticide container residue will be disposed of in a manner inconsistent with its label. All properly identified excess serviceable pesticides will be turned in to the local or servicing Defense Reutilization and Marketing Office for disposal.

p. Pesticide Application Records. Adequate records of all pest management operations performed by engineer personnel, contractors, nonappropriated fund activities, self-help, lessee, and installation medical authority will be maintained by the installation engineer.

(1) DD Form 1532-1. Complete daily pesticide application and surveillance records on DD Form 1532-1. This record provides a permanent historical record of pest control operations and pesticides used for each building, structure, or outdoor site.

(2) DD Form 1532. DD Form 1532 will be used to report all pesticide use and pest control operations. Retain a copy at the installation and submit copies to both the MACOM PMC and the Center for Health Promotion and Preventive Medicine (CHPPM).

NOTE: Instructions for filling out DD Forms 1532 and 1532-1 are found In the Records and Reports Chapter.

1-38. ARMY REGULATION 200-1, ENVIRONMENTAL PROTECTION AND ENHANCEMENT

a. Elements of the Regulation. This regulation prescribes Department of the Army responsibilities, policies, and procedures to preserve, protect, and restore the quality of the environment. This law incorporates:

- All applicable statutory and regulatory requirements in the areas of research and development.
- Water resources management.
- Solid and hazardous waste management.
- Noise abatement.
- Oil and hazardous substances spill contingency planning, control, and emergency response.
- Environmental restoration.
- Asbestos management.
- Radon reduction.
- Other environmental programs.

b. Chapter 8. Chapter 8 prescribes policy and procedures for the prevention and control of spills of oil and hazardous substances. The requirements for the installation's Spill Prevention, Control, and Countermeasures Plan and Installation Spill Contingency Plan are found in this chapter. Pesticide storage facilities and pesticide spills should be addressed in both of these plans.

1-39. ARMY REGULATION 200-2, ENVIRONMENTAL EFFECTS OF ARMY ACTIONS

This regulation sets forth policy, responsibilities, and procedures for integrating environmental considerations into Army planning and decision making. It establishes criteria for determining what Army actions are categorically excluded from requirements to prepare an Environmental Impact Statement (EIS) and lists applicable categorical exclusions.

a. Environmental Assessment (EA). An installation pesticide, fungicide, herbicide, insecticide, and rodenticide use program normally requires an environmental assessment. An EA is made to determine the extent of environmental impacts of a project and decide whether or not those impacts are significant.

b. The Environmental Impact Statement (EIS). An EIS is a public document with a primary purpose of ensuring that the National Environmental Policy Act (NEPA) policies and goals are incorporated early into the programs and actions of Federal agencies.

- An EIS is required to provide a full and fair discussion of significant environmental impacts.
- Along with other project documentation, the EIS provides a basis for informed decision making.
- Further, it allows public review and comment on the proposal.

1-40. ARMY REGULATION 40-5, PREVENTIVE MEDICINE

This regulation explains the Army Preventive Medicine Program. It prescribes a comprehensive disease prevention and environmental enhancement plan of action for the US Army at fixed installations and in support of field forces. Chapter 10 deals specifically with pest and disease vector prevention and control.

1-41. PESTICIDE REDUCTION INITIATIVE

In the Comprehensive Pollution Prevention Strategy Memorandum dated 11 August 1994, the DoD is directed to take immediate action to implement the strategy's objectives. Pest Management programs are addressed in Object 3, sub-objective 10, which tasks the DoD to fully implement IPM throughout the DoD to reduce pesticide risk. The goal of this objective is to reduce the amount of pesticide applied annually, as measured in pounds of active ingredient, by 50 percent from the FY 1993 baseline, by 30 September 2000.

EXERCISES, LESSON 1

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. What is the purpose of the FIFRA and its amendments? _____

2. A "notice of intent to cancel" means that the Environmental Protection Agency has found

3. List four pesticides that have been cancelled by law.

   a. _____

   b. _____

   c. _____

   d. _____

4. The document which applies to all employees applying any restricted use pesticides on DoD property is DoD directive _____, Plan for the Certification of Pesticide Applicators.

5. What is the purpose of the Clean Water Act of 1977? _____

_____

_____

_____

6. List three goals of the Clean Water Act, the goals listed in this lesson.

a. _____

_____

b. _____

_____

c. _____

_____

7. Regarding an accidental hazardous substance spill, list the two plans all military installations are required to have.

a. _____

_____

b. _____

_____

8. List the two major purposes of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

a. _____

_____

b. _____

_____

9. What is the responsibility of the US Fish and Wildlife Service regarding endangered species? _____

_____

_____

_____

_____

10. The purpose of OSHA is to _____

_____

_____

11. The Toxic Substances Control Act of 1977 authorizes the EPA to _____

_____

_____

_____

_____

_____

12. The Army regulation which reflects the current Army policies, procedures, and standards for pest management at installations under the Department of Army jurisdiction is AR _____, titled _____

_____.

13. Preparing a pest management plan, supervising and directing pest management operations, and conducting preventive pest maintenance and surveillance inspections on an Army installation is the responsibility of the

_____

_____.

14. On an Army installation, establishing health and personnel safety criteria for pesticide operations and conducting surveillance of medically important pests is the responsibility of

_____

_____.

15. Name the number and title of the Army regulation which incorporates all applicable statutory and regulatory requirements in many areas of the environment including water resources management; solid and hazardous waste management; noise abatement; radon reduction; and environmental restoration.

a. Number: AR _____

b. Title: _____

_____

16. Army Regulation 200-2, Environmental Effects of Army Actions establishes policy, responsibilities, and procedures for _____

_____

_____

17. What is the Army regulation which explains the Army preventive medicine program?

_____

_____

18. A major goal in the Comprehensive Pollution Prevention Strategy Memorandum of 11 August 1994 is to reduce the amount of pesticide applied annually, as measured in pounds of active ingredient, by _____ % from the FY 1993 baseline by 30 September 2000.

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 2	Records and Reports.
LESSON ASSIGNMENT	Paragraphs 2-1 through 2-18.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to prepare, maintain, and disseminate pesticide records and reports IAW AR 420-76.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the reference listed above, you should be able to: 2-1. Identify the purpose of specific records and reports. 2-2. Identify the installation personnel who should be notified by letter of the pesticides used and stored on the installation. 2-3. Identify the various records and reports required in a land management and/or pest control shop. 2-4. Identify the procedures for completing the DD Form 1532. 2-5. Identify the personnel responsible for input and review of the DD Form 1532.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

RECORDS AND REPORTS

Section I. GENERAL INFORMATION

2-1. THE NEED FOR A PEST CONTROL REPORT

The need for accurate records and reports within the pest control industry cannot be over emphasized.

- There have been several claims of pesticide misuse on military installations, claims that could be refuted by producing accurate records of pesticide use.
- The Pest Control Report is used by various agencies within DoD and the Federal government to determine the amounts of toxic materials being applied.
- The report is also used for forecasting and compiling data on pesticide usage.

2-2. THE USEFULNESS OF DATA

This data is useful in assessing the resistance of pests to various pesticides and in installation monitoring programs and the resolution of those problems encountered.

- Good safety practices require the periodic reporting of those situations that could be hazardous to the health of pest control personnel, the community, and fire department personnel.

- Recent Federal legislation, FEPCA, and OSHA require accurate and timely reporting of all activities relating to the use of toxic materials.

- Appropriate documentation of those work situations that could be hazardous to the health of pesticide applicators and the community is also required.

2-3. TYPES OF RECORDS AND REPORTS

a. Pest Management Maintenance Record, DD Form 1532-1. All Army installations will maintain complete daily pesticide application and surveillance records using DD Form 1532-1 (Pest Management Maintenance Record). These records account for all operations and provide a permanent historical record of pest control operations and pesticides for each building, structure, or outdoor site.

b. Pest Management Report, DD Form 1532. DD Form 1532 (Pest Management Report) is utilized by the installation engineer to report all pesticide use and pest control operations.

- Each installation or subinstallation performing pest control must prepare the report monthly.

- These reports will include pest control operations conducted by the following: DEH, Contractors, GOCOs, Nonappropriated fund activities, all outgrant lease holders, self-help, Veterinarian Services, and Preventive Medicine Services.

- The report is prepared and signed by the installation pest management coordinator and verified and signed by the Director, DEH.

- Copies of the report are furnished to the MACOM PMC, Installation Medical Authority, and the regional Direct Support Activity, CHPPM.

2-4. PURPOSES OF RECORDS AND REPORTS

The purpose of records and reports is to trace pest control operations for each installation on an overall basis and by individual site. There are six primary purposes for maintaining records and reports, and they are:

a. Safety Considerations. By documenting what type of pest control work that is performed at each individual site on what date, a historical data base is developed.

b. Documentation of Work Accomplished. This is important for justifying man hours required to accomplish pest control operations on an installation.

c. Forecast Future Work Needs. Trends can be followed or predicted based on the historical data from previous years for each site.

d. Army-Wide Pesticide Monitoring Program. DoD is required to reduce pesticide usage. Through the use of records and reports, unnecessary pesticide application can be monitored, and alternative pest management strategies can be recommended and implemented.

e. Pesticide Misuse. Records and reports provide the basis to track the misuse of pesticides in handling pest problems. Recurring pest problems need to be reevaluated and alternative methods of control examined.

2-5. PESTICIDE INVENTORY

Any activity that is storing pesticides needs to maintain an inventory.

- Each pesticide in stock must have an inventory sheet that has the following information:
  - -- Commercial name.
  - -- Active ingredient.
  - -- Percentage active ingredient.
  - -- National stock number.
  - -- EPA registration number.
  - -- Complete pesticide description.
- Enter the date of receipt of each pesticide and quantity on the sheet.
- As pesticide is removed for use, enter the amount and date.
- Each sheet should show how much of that pesticide is currently on hand.

2-6. INSTALLATION ACTIVITIES REQUIRING NOTIFICATION

a. The Fire Marshall and the Police. The fire marshall and the police need to be informed of the location of the pesticide storage facility.

- Include a floor plan of the building, showing the storage room and location of all exits.
- Provide the number of all pest control personnel to include the pest management coordinator.
- Submit an updated pesticide inventory on a monthly basis to include all MSDS for all pesticides currently on site.
- If a site requires fumigation, coordinate with both fire and police departments concerning the specific hazards and precautions that may be necessary.
- See sample letter on page 2-29 of this lesson.

b. The Installation Medical Authority.

- Provide a letter to the installation medical authority listing the toxic materials by major groups (e.g., carbamate, organophosphates).
- List possible routes of poisoning and any peculiar properties of pesticides, such as reactivity, volatility, flashpoint, etc.
- Provide labels or MSDS for all pesticides kept in stock.
- Determine the policy for handling personnel experiencing acute pesticide poisoning.
- Ensure that the medical authority has the pesticide hotline and local poison information phone numbers.
- See sample letter located on page 2-30 of this lesson.

Section II. INSTRUCTIONS FOR THE USE OF THE PEST MANAGEMENT MAINTENANCE RECORD DD FORM 1532-1

2-7. GENERAL INFORMATION

a. Value of Records. The Pest Management Maintenance Record (DD Form 1532-1) provides a standard method for recording pesticide use and other pest control information at an installation.

- Use of the record complies in part with Federal Regulations 40 CFR 171-11 (c) (7) of the Federal Insecticide, Fungicide and Rodenticide Act, as amended.

- This record is used as a permanent maintenance record and history of pest control operations at a particular site (structure or area).

- The record also provides continuity in the management and performance of pest control operations at the installation level.

- Use and analysis of these records will identify structures, designs, and areas which have significantly more pest problems than others.

- Historical pest control data can be used to verify warranties, correlate sites, and treatment and to facilitate cost effective pest management.

b. Maintaining Records. These records shall be maintained in the installation pest control facility. When pest control operations are performed for a structure or an area, record it on the record form and set it aside until the information is listed on the Pest Control Report (DD Form 1532) at the end of each month. Then file the pest management maintenance record for future use.

c. Reviewing Records. A records review should be scheduled annually, or in conjunction with the on site visits by the major command or engineering field division pest management consultants. Information of pest infestation treatment schedules and pesticide application trends gained from this analysis can then be used to adjust and improve the installation pest management plan.

2-8. DATA ENTRY ON DD FORM 1532-1

a. Entries.

- Bldg/Area. On the top of the record in the space marked "Bldg/Area," enter the building or structure number when a maintenance record is needed. This number is found in the plant account of facilities inventory.

- Outdoor Areas. Similarly, for outdoor areas to be maintained on record, enter a description or area number, if available.

- Next Space. In the next space, enter the size of the item to be maintained.

- Standard Measurement Units. A legend at the bottom of the record provides standard measurement units.

  -- Type of Construction. In the space marked "Type of Construction," enter a code letter from the legend to designate the major type of construction. More than a code letter may be used if desired.

  -- Use Designation. In the last space marked "Use Designation," enter information to identify the major use of the building, structure, or area.

b. Pest Control Operation Information. Enter this information for each pest control operation conducted at the structure or area.

- Date. Enter the date of the operation in the date column as year, month, and day.

- Units Serviced and Work Origin. Enter the part of the building involved such as the room or an apartment number, or, in the case of outdoor areas, a site designation such as "south section of parade ground, trees." Enter the work origin, using the symbols in the legend to show how the work was initiated.

- Units of Measure. Enter the size of the treated or protected area using the measurement units in the legend.

- Target Pest. Enter the name of the target pest. Be specific, if possible.

- Control Operation. Enter information to identify how the control operation was performed (misting, hand spraying, fogging, trapping).

c. Pesticide Use. If a pesticide was used, enter the pesticide name and EPA registration number in the first space. Enter the concentration of the finished formulation in the middle space and the amount or quantity used in the last space. If no pesticide was used, leave this section blank.

d. Labor-Time. Enter the time required for the pest control operation in this space. Include all time associated with the job; for example, travel preparation, execution, and clean-up. Do not include the pretreatment inspection or post-treatment survey.

e. Application Initials. Enter the initials of the individual responsible for performing the work. If more than one person was involved, the crew leader should initial the record.

f. Remarks. Using the date as a cross reference, enter any remarks in this space which pertain to a pest control operation reported on the record. If a diagram of areas treated is desired, it may be put in this space or put on a separate card and attached to the record.

NOTE: Additional Records. As records become filled, attach new records as needed and continue the maintenance record.

Section III. INSTRUCTIONS FOR THE PREPARATION AND USE OF THE PEST MANAGEMENT REPORT, DD FORM 1532

Section 1. GENERAL INFORMATION

2-9. PURPOSE

The purpose of the Pest Management Report is to provide a standard procedure for recording and reporting pest control operations conducted on military property.

- The Pest Management Report, when reviewed monthly, can be an important tool for monitoring safety and effectiveness of pest management operations and for ensuring the appropriate protection of the environment.
- The report also provides data for efficient management for current installation pest control programs and an overall record of past programs.

a. Use. Reporting installations will use the Pest Management Report to record all pest control operations except those operations performed by persons for their own personal relief.

- Land-use permit holders who conduct pest control operations must report such actions at prescribed intervals to the host activity so that the information may be added to that installation's pest control report.
- In order to maintain complete records of environmental impact, all pest control operations will be reported.
- The Pest Management Report form allows reporting total program information for management, monitoring, and record purposes.

b. Additional Uses. The Pest Management Report is used to report pest control operations monthly and the time required for their performance in any report month, including contract operations. The form is also used to report other items which contribute to the pest control function such as leave, training, program planning and coordination, and maintenance of shop facilities or equipment so that a total program effort can be accurately determined.

2-10. REPORT LANGUAGE

Pest management information is machine processed; all report data must adhere to a uniform system of "report language." Standard

report terms have been developed for describing and reporting most pest control techniques and materials.

- The terms are arranged in functional groups or categories.
- Both the descriptive terms used to look up and classify any given operation and the report terms for actual entry on the DD Form 1532 report are listed in Section 5.
- Where standard units are required, such as for acres, pounds, gallons, etc., report units are also listed.
- Only report terms, descriptive terms, and report units listed in this instruction shall be used on the form.
- All other terms will be rejected by the processing unit.
- In many cases, the descriptive term and the report term are similar while others may differ by only one letter, so it is necessary to carefully check the report terms.
- Descriptive terms and report terms in Section 5 are listed in three principal categories: (1) Pests; (2) Operations; (3) Pesticides.

Section III. INSTRUCTIONS FOR THE PREPARATION AND USE OF THE PEST MANAGEMENT REPORT, DD FORM 1532

Section 2. SUBMISSION PROCEDURES

2-11. INSTALLATION RESPONSIBILITIES

The Pest Management Report (DD Form 1532) will be prepared and submitted monthly to the appropriate Army or Air Force major command, or Navy Engineering Field Division. No cover letter is required. To assure accuracy, the typed report shall be returned to the originating office for review and signature by the DoD certified pest control supervisor, inspector, or pest control technician. It is then signed by the installation engineering officer or his representative and put into distribution no later than the 15th day after the end of each month. Three copies of the form will be distributed as below for each service department.

a. Navy. Copy 1 (original) will be forwarded to the cognizant EFO Special Assistant for Applied Biology. For activities with Public Works Departments, copy 1 is to be signed by the Public Works Officer. For Public Works Centers or Pubic Works Lead Activities, where tenant commands or activities may utilize the services of the Public Works Center or Lead Activity pest control shop, copy 1 is to be signed by the Commanding Officer of the Center or Lead Activity. The second copy is the be retained by the Medical Officer, and the third copy is to be retained by the engineering officer as shown below.

- ☼ Copy 1--To Appropriate Engineering Field Division Applied Biologist.
- ☼ Copy 2--Installation Medical Officer.
- ☼ Copy 3--Installation Engineering Officer.

b. Army. Distribution of the Pest Management Report will be as follows:

- ☼ One copy shall be retained by the facilities engineer at the pest management shop facility.
- ☼ One copy shall be furnished to the installation medical officer.
- ☼ One copy shall be forwarded to the appropriate major command pest management professional.
- ☼ One copy shall be forwarded to the USAEHA, Aberdeen Proving Ground, Maryland 21010.

- ☼ One copy shall be forwarded to the appropriate medical entomologist at CHPPM regional divisions.

c. Air Force. Copy 1 will be forwarded to MACOM for review by the MACOM pest management professional and coordination by DE and SG. Copy 2 will be retained by the Director of Base Medical Service or his representative. Copy 3 will be retained by the Base Civil Engineer or his representative. The DD Form 1532 will also be used as the data input to the Pest Management Report (RCS:DD-M-(A and AR)-1080), and this data will be forwarded to MACOM for the MACOM cumulative 1080 report.

2-12. MAJOR COMMAND OR ENGINEERING FIELD DIVISION RESPONSIBILITIES

Installation data received by MACOM or EFD on DD Form 1532 will be reviewed promptly by the assigned pest management consultant to provide operational-safety, monitoring, and guidance as necessary, and to ensure report accuracy. If situations are reported which are hazardous to the applicator, to other personnel, or to the environment, the consultant shall immediately contact the reporting installation to correct the problem. After this review, disposition of the DD Form 1532's will be as follows for the service departments.

a. Navy. The data will be transferred to punched cards and transmitted via AUTODIN or mailed to the Commander, Naval Facilities Engineering Command, 200 Stovall Street Alexandria, Virginia 22332, Attention Code 011, for machine edit. Punched data shall be completed and transmitted by the 30th calendar day after the end of the month. Edited data will be returned to the EFD in time for correction and resubmission with the following-month's -transmission, as appropriate.

b. Army. (Word to be developed by Army representative)

c. Air Force. Data from DD Form 1532, will be checked against data inputs AUTODINed from installations to MACOM for the 1080 report, and any discrepancies noted will be reconciled. The DD Form 1532's will be maintained in MACOM files for at least two years.

Section III. INSTRUCTIONS FOR THE PREPARATION AND USE OF THE PEST MANAGEMENT REPORT, DD FORM 1532

Section 3. PREPARATION GUIDANCE

2-13. DD FORM 1532 HEADER INFORMATION

Before pest control data is entered on the form, identification and address information must be entered in the appropriate spaces on the header.

- The address of the appropriate command should be entered in the box marked "TO" and the address of the reporting installation should be entered in the box marked "FROM."
- Near the upper right-hand corner of the form, a series of small, numbered spaces appear. For Navy installations, enter number of the Naval District in the spaces marked "C.D. CODE" (1,2).
- In the spaces marked "UIC" (Unit Identification Code), enter a letter in space 3 to designate the service component ("N" for Navy, or "M" for Marine Corps activities). UICs for all Department of the Navy activities are listed in the Navy Comptroller Manual, Volume 2, Chapter 5. Enter the UIC in space 4 through 8. Enter the last two digits of the calendar year in spaces 9 and 10, and a numerical designation of the month in which operations were performed in spaces 11 and 12.
- Army and Air Force procedural input is required.

2-14. RECORDING PEST MANAGEMENT INFORMATION ON THE FORM

a. Recording Operations. Each line of the DD Form 1532 can be used to report a complete pest control operation.

- Most operations using a single pesticide can be entered without difficulty.
- In operations where two or more pesticides are used as in a tank mix or premixed pesticides, each pesticide is reported as if it were a separate operation.
- When the application of two or more pesticides is done simultaneously, the man-hours are simply divided equally for each chemical.

b. Fields and Columns of the Form. The form is divided into specific fields and columns. These are described in the order they appear on the form. The "spaces" on the form refer the data card entry and do not apply to this discussion.

2-15. PEST

a. Column (a). (Name). Find the most appropriate descriptive term from Section 5 for the pest and enter the corresponding report term on the form.

b. Example. For example, for cockroach control find "cockroach" in the descriptive terms and enter the corresponding report term "ROACHES" in column (a) as shown.

- If there is no suitable descriptive term, find the general grouping which is most appropriate and use the "Other" designation, if listed.
- No suitable descriptive term being available, a rattlesnake would fall into the "Miscellaneous Pests" grouping and be described as an "Other Vertebrate Pest."
- The report term for this is "OVE" to which the name of the pest is added, as in "OVESNAKE."

2-16. OPERATIONS

a. Column (b). (Operation Name). Find the most appropriate descriptive term listed in Section 5 and enter the corresponding report term. Note that operation names are paired with area units (e.g., AC, MSF, etc.). Only the indicated area unit can be used. Nonpest oriented program operations or functions are reported (in this column).

b. Column (c). (Total Units Treated). This indicates the area, volume or individual, items treated. For some operations such as trapping or crack-and-crevice treatment, the area protected will be reported. The numerical value must be reported as a whole number; therefore, rounding off to the nearest whole number may be necessary. Operations which involve treatment of a fraction of a unit area (e.g., 1/8 of an acre) can be held over and added to subsequent reports until cumulative a whole unit area has been treated.

c. Column (d). (Area Unit). These are located in the Operation Names. The report units MSF, MCF, and AC respectively indicate thousand square feet, thousand cubic feet, and acres.

d. Column (e). (Site). Enter the report term for the most appropriate descriptive term for the site where a control operation was performed. A single exception is in applications made to trees. Regardless of the type of operation (i.e., misting, spraying power, etc.), the report term used in column (d) would be "EA."

2-17. PESTICIDES

a. Column (f). (Pesticide Name). Enter the report term for the pesticide used in the control operation, if any. If two or more pesticides are simultaneously applied, they must be reported separately.

b. Column (g). (Pesticide Form). Enter the report term for the formulation if a pesticide was used.

c. Column (i). (Application Unit). Enter either PDW, ZGL, or FLO in this column as appropriate, or leave blank if no pesticide was used. These are found paired with the pesticide formulation report terms.

d. Column (j). (Final Concentration). Enter the concentration of the pesticide in percent if any was used in the operations.

- For example, if a 1% material was applied, enter 1.0 in the column.
- If .025% bait was used, enter .025. Enter no more than three digits and the decimal point.
- If necessary, round off to three digits.

NOTE: Some operations cannot be reported in column (j). See specific notes in Section 5. Concentrations should be reported in column (j) or (k and 1), but not in both.

e. Column (k) and (l). (Rate). These columns are used together to report the rate of application per area unit of the pesticide.

- Enter the number of pounds in pesticidal material in column (k) and its concentration in percent in column (1).
- For example, 200 pounds of a 5% pesticide dust was used to treat 2 acres. There are two ways it can be reported.
  - In both, the amount (200 lbs) would be entered in columns "h" and "i". The differences are in reporting the pesticide concentration or rate.
  - In the first method, the application rate (100 lbs of dust per acre) would be entered in column (k), and the concentration (5% would be entered in column (1) as 5.0.
  - The second method used for reporting the same operation involves the actual amount of toxicant or active ingredient applied per acre (5 lbs in column (k) and 100% in column (1).
- Either report method would be correct.

f. Column (m). (Procurement). Indicate the supply source of the pesticide by entering an "Sm, "Nu, "G" or "C" in column (m).

- "S" indicates standard applies to non-standard materials procured through open purchase.
- "G" applies to pesticides obtained from the General Services Administration.
- If the supply source cannot be identified, it should be entered as non-standard.
- "C" indicates materials supplied by contractors or that the operation was performed by contract.
- Pesticidal materials used by land-use permit holders or leasers will be reported as non-standard.

2-18. TIME

a. Column (n). (Time). Indicate the time in hours devoted to all aspects of the control operation.

- This may include such tasks as inspections, preparation of pesticides, application, clean up, and travel time.
- Supervision, for mosquitoes or termites are reported as separate operations.

b. Commercial Service Time/ Managerial and Administrative Time. Time expended by commercial service must be reported in conjunction with their control operations. Managerial and administrative time related to the pest control function shall also be reported.

CATEGORY 1--TARGET PESTS

DESCRIPTIVE TERMS	Col (a) REPORT TERMS
Group I. DISEASE VECTORS--FLIES, GNATS AND MOSQUITOES	
1. Culicoids (Sand Flies, Punkies, No-See-Ums)	CULICOIDS
2. House Flies and Other Filth-Flies	FILTHILIES
3. Mosquitoes (Culicids)	MOSQUITOES
4. Filter Flies, Drain Flies (Psychodids)	PSYCHODA
5. Black Flies, Buffalo Gnats (Simuliids)	SIMULIIDS
6. Stable Flies, Dog Flies, Biting House Flies (Stomoxys)	STOMOXYS
7. Horse Flies, Deer Flies (Tabanids)	TABANIO
8. Midges, Gnats (Chironomids)	CHIRONOMID
9. Other Diptera (Miscellaneous Flies, Gnats, etc	OTH (add name)
Group II. HOUSEHOLD, NUISANCE, AND MISCELLANEOUS ARTHROPOD PESTS	
1. Ants, Other (Carpenter Ants--See Wood Destroying Pests)	ANTS
2. Fire Ants	FIREANTS
3. Bedbugs	BEDBUGS
4. Centipedes	CENTIPEDES
5. Clover Mites	CLOMITES
6. Crickets	CRICKETS
7. Cockroaches	ROACHES
8. Earwigs	EARWIGS
9. Fleas	FLEAS
10. Lice	LICE

DESCRIPTIVE TERMS	REPORT TERMS
11. Mites and Chiggers (See also Clover Mites above)	MITES
12. Pillbugs and Sowbugs	PILLBUGS
13. Scorpions	SCORPIONS
14. Silverfish, Millipedes, Psocids, Firebrats	SLVRSOCID
15. Spiders	SPIDERS
16. Ticks	TICKS
17. Urticating Insects (Caterpillars, etc.)	URTICATING
18. Wasps, Bees, and Homets	WOB
19. Other Disease Vectors or Venomous Arthropods.	ODV (add name)
20. Other Arthropod Pests	OAR (add name)

Group III. PLANT PESTS

1. Arthropod Plant Pests Infesting Roots and Soil (White Grubs, etc.)	ROO (add name)
2. Sap-Sucking Arthropods (Thrips, Aphids, etc.)	SAP (add name)
3. Leaf-Chewing or Defoliating Insects (Leaf Miners, Tent Caterpillars)	LEA (add name)
4. Boring & Girdling Insects (At acking Plants Above Ground)	BRG (add name)
5. Japanese Beetles	JPBEETLES
6. Gypsy Moth	GYPSY MOTH

Group IV. STORED PRODUCTS PESTS

1. Arthropod Pests of Stored Foods	FOODPESTS
2. Arthropod Pests of Fibers and Fabrics	FIBFABPST

DESCRIPTIVE TERMS	REPORT TERMS
Group V. WOOD-DESTROYING PESTS	
1. Termites, Subterranean	SUBTERMS
2. Termites, Orywood	DRYWDTERM
3. Termites, Dampwood	DAMPWDTERM
4. Powder-Post Beetles (Lyctids, Anobiids, etc.)	BEETLESPP
5. Old House Borers	OLDHOUSEBR
6. Carpenter Ants	CARPENTANT
7. Other Wood-Destroying Insects	OWI (add name)
8. Wood-Destroying Fungi	FUNGIWD
9. Marine Borers (Shipworms and Gribbles)	MARINEBOR
10. Ottier Wood-Destroying Pests	OWD (add name)
Group VI. VERTEBRATE AND MISCELLANEOUS PESTS OTHER THAN ARTHROPODS	
1. Rats	RATS
2. Mice	MICE
3. Ground Squirrels	GRDSQURLS.
4. Other Rodents (Woodchucks, Pocket Gophers, etc.)	RODENTSOTH
5. Bats	BATS
6. Birds	BIRDS
7. Fish	FISH (add name)
8. Other Vertebrate Pests (Rabbits, Moles, Mongooses, etc.)	OVE (add name)
9. Snails and Slugs	SNAILSLUGS
10. Snakes	SNKES
11. Nematodes	NEMATODES
12. Other Miscellaneous Pests	OTP (add name)

DESCRIPTIVE TERMS	REPORT TERMS
Group VII. WEED PESTS	
1. Algae	ALGAE
2. Other Aquatic Weeds	AQUATICWDS
3. Grassy Weeds	GRASSYWEED
4. Herbaceous Broad-Leaved Weeds	BOLVDWEEDS
5. Mixed Grassy and Broad-Leaved Weeds	MXGRABOLVO
6. Woody Vegetation, Brush	BRUSH
7. Mixed Herbaceous and Woody Weeds	MXBDLBRUSH
8. Soil Sterilization (Eradication of All Vegetation)	ALLVEG
Group VIII. PLANT AND TURF DISEASES	
1. Turf Diseases (Dollar Spot, Anthracnose, Brown Spot, Smut, Rust, etc.)	TURF (add name)
2. Ornamental Plant or Tree Oiseases (Flux, Wilt, Blight, Dutch Elm Disease)	ORN (add name)
3. Other Plant Diseases	OPO (add name)

END OF CATEGORY I: TARGET PESTS

CATEGORY 2 OPERATIONS

DESCRIPTIVE TERMS	REPORT TERMS		
	Col (b)	Col (d)	Use Columns
Group I: EXTERIOR CONTROL OPERATIONS OPERATIONS			
1. Fogging, Thermal or Nonthermal and ULV, Outdoor	FOGGING	AC	j or k and 1
2. Misting(Use EA for Tree Applications Only)	MISTING	AC, EA	j or k and 1
3. Spraying, Hand (Use EA for Tree Applications Only)	SPHAND	AC, EA	i or k and 1
4. Spraying, power (Use EA for Tree Applications Only)	SPPDEQ	AC, EA	j or k and1
5. Spraying, Aerial	SPAIR	AC	k and 1
6. Dust/Granule Application, Hand	DGHAND	AC	k and 1
7. Dust/Granule Application, Power	DGPEQ	AC	i or k and 1
8. Dust/Granule Application, Aerial	DGAIR	AC	j or k and 1
9. Systemic Application to Trees (Other Than Above)	SYSTEMAPP	EA	
10. Receptacle Treatment (Catch Basins, Barrels, Grease Traps, Transportable Garbage Containers (TGCS) and Other Individual Receptacles	RECEPTREAT	EA	
11. Residual or Spot Treatment to Building Exteriors (Spraying, Dusting, etc.)	EXTRESIDTR	MSF, MLF	j
12. Baiting (Report Area Protected)	EXBAIT	AC	j or k and 1
13. Barrier, Chemical	CHEMBAR	MLF	i
Group II. INTERIOR CONTROL OPERATIONS			
1. Indoor Residual Treatment (Report Area Treated); for Crack-and-Crevice Treatment (Report Area Protected)	RESIDTR	MSF, MLF	j
2. Space Treatment (Bug-Bombs, Flitguns, Aerosol Generators, and DDVP Strips) (Report Area Treated)	SPCTR	MCF, MLF	j
3. Baiting (Chemical or Biological Control Only) (Report Area Protected)	INBAIT	MSF, MLF	j

DESCRIPTIVE TERMS	REPORT TERMS		
	Col (b)	Col (d)	Use Columns
Group III. FUMIGATION			
1. Vacuum Chamber Fumigation	VACUUMFUM	MCF	j or k/l
2. Atmospheric Fumigation (Stack, Car, Ship, Equipment, etc.)	ATMOSFUM	MCF	j or k and 1
3. Structural Fumigation	STRUCFUM	MCF	j or k and l
4. Soil Fumigation (for weed seeds, nematodes, or plant diseases, etc.) (for burrow fumigation) (Report Area Protected)	SOILFUM	SY	j or k and l
5. Deactivation of Fumigants Received for Intraout Fumigation of Itatlroad Cars (Report RRC as site and enter time only)	DEACTIVATE		
Group IV. SOIL TREATMENT FOR TEMITE CONTROL			
1. Surface Soil Treatment (Surface Pretreatment or Corrective Treatment, SubslabInjection, Horizontal Rodding)	SURSOILTR	MSF, MLF	j
2. Trench Treatment (Digging, Vertical Rodding) (Convert linear feet or trench directly to cubic feet)	TRNSOILTR	CF	j
3. Rodding (Vertical or Horizontal) and Subslab Injection (Convert linear feet of rodding directly to cubic feet of soil)	INJECTSOIL	CF	j

DESCRIPTIVE TERMS	REPORT TERMS		
	Col (b)	Col (d)	Use Columns
Group V. PHYSICAL AND MECHANICAL CONTROL OF PEST ORGANISMS			
1. Earthwork, Sanitary Landfill	SANITFILL	CY	
2. Earthwork, Hydraulic Landfill	HYDRAFILL	MCY	
3. Earthwork, Ditching (New and Maintenance)	DITCHING	MLY	
4. Clearing (Weed, Brush, and Selective Tree Removal	CLEARING	AC	
5. Barrier Construction (Screening, etc.) - Interior	BARRIER	MSF, MLF	
6. Trapping Exterior	EXTRA	PAC	
7. Trapping, Interior	INTRAP	MSF, MLF	
8. Steam Cleaning Trucks, Transportable Containers, or Garage Bins	STEAMCLEAN	EA	
9. Other Mechanical Control (Manual Removal. of Pests, Nests or Infested Materials)	OMCONTROL	AC, MSF or EA	
10. Grazing (for weed control)	GRAZING	AC	
Group VI. WOOD PROTECTION FROM WOOD DECAYING ORGANISMS			
1. Treated Lumber Installed (Pressure Treated)	TRLUMBINST	MBF	
2. In-Place Treatment, Structural or Dimension Materials	STINPLTERMSF	MLF	j
3. In-Place Treatment, Poles, Include Ground-Line Treatment	POLEINPLTR	EA	
4. In-Place Treatment, Piles	PILEINPLTR	EA	
5. Poles Installed (Pressure Treated)	POINSTALTR	EA	
6. Piles Installed (Pressure Treated)	PIINSTALTR	EA	
7. Dip/Soak Treatment-Lumber & Plywood	DIPTRLUMB	MBF	
8. Dip/Soak Treatment-Pallets	PALLDIPTR	EA	

DESCRIPTIVE TERMS	REPORT TERMS

Group VII. INSPECTION AND SURVEY OF PEST PROBLEMS.

(Not a direct part of control operations.) (Indicate opertional area in column e and the hours in column o. Leave columns c, d, and f through m blank).

1.	Inspection or Survey by Medical Department Personnel	MEODINSSUR
2.	Inspection or Survey by Public Works Department Other Than for Contract Performance	ENGOINSSUR
3.	Inspection or Survey of Stored Products by Veterinary Personnel	VETINSUR
4.	Timber Survey by Forestry Personnel for Forest Insect Pests (Report this operation only for timber or ornamental trees and include acres inspected.)	TIMBSURVEY

Group VIII. PROGRAM ADMINISTRATION AND MAINTENANCE.

(Not a direct part of control operations. Report time only.)

1.	Program Planning, Estimating, Scheduling, Coordinating, and Reporting	PROGRAMMING
2.	Training (includes on-the-job, correspondence, in-service, and formal courses to establish or improve competency in pest control)	TRAINING
3.	Maintenance, Calibration, and Cleanup of Equipment, Vehicles, and Shop Facilities	MAINTENANCE
4.	Nonprogram Functions Supporting Pest Control (Medical Examinations, Blood Tests, Annual, Sick and Administrative Leave, and Indirect Training)	NONPROGRAM
5.	Quality Assurance Evaluation or Inspection of Contractor Performance--(Enter on line following report of the pest control operation evaluated)	QAEVALUATE
6.	Decontamination of Areas, Materials, or Equipment Resulting from Pesticide Contamination (Use "Deactivatell for residue disposal from intransist fumigation operations	DECONTAMIN

DESCRIPTIVE TERMS	REPORT TERMS	
	Col (e)	Col (d)
	Use Columns	

Group IX. OUTDOOR SITES (TERRESTRIAL)

1.	Wooded Areas (including forest lands)	WOO	
2.	AC Open Areas with Brush	OPB	AC
3.	Open Areas with Grass, May Have Some Trees and Shrubs (Lawns, Parade Grounds) (omit lands)	OPG	AC
4.	Golf Course Fairways and Greens	GFG	AC
5.	Landfills, Refuse Dumps	LDF	AC
6.	Open Areas with No Vegetation, Mostly Paved or Barren	OPX	AC
7.	Trees or Ornamental Shrubs Treated Individually (Report only with Hand Spraying, Mist Power Spraying, or Systemic Operations)	TRE	EA
8.	Croplands (areas under outlease)	CRP	AC
9.	Grazing Land (areas under outlease)	GRZ	AC

Group X. OUTDOOR SITES (AQUATIC)

1.	Marsh/Swamp (Do not include temporary pools or flooded areas	MOS	AC
2.	Waterway (Moving water such as ditches, streams, rivers, harbors)	WAW	AC
3.	Impoundment (Standing water such as lakes, ponds, temporary pools)	IMP	AC
4.	Underground Sewer Lines (If operation is RESIDTR, SPCTR, or INBAIT, use MLF as area unit)	UGS	MLF
5.	Receptacles, Manholes, Catch Basins, Barrels, or Water Containers	REC	EA

DESCRIPTIVE TERMS	REPORT TERMS		
	Col (e)	Col (d)	Use Columns
Group XI. INDOOR SITES AND STRUCTURES			
1. Food Handling Buildings (Preparation and Serving Only)	FHB		MSF
2. Residential and Family Quarters	RES		MSF
3. Barracks and BOQs	BRQ		MSF
4. Hospitals and Medical Laboratories.	HOL		MSF
5. Recreation Buildings and Chapels	RCH		MSF
6. Office and Administrative Buildings	OFF		MSF
7. Industrial Buildings, Shop Areas. and Nonmedical Laboratories	IND		MSF
8. Storage Buildings and Warehouses	WHS		MSF
9. Utility Buildings	UTL		MSF
10. Waterfront Structures (Pier, wharf, with or without buildings)	WAT		MSF
11. Greenhouses	GRH		MSF
12. Exchanges and Commissaries	EXC		MSF
13. Kennels and Stables	KEN		MSF
14. Brigs or Prison Cells	BRG		MSF
Group XII. MISCELLANEOUS SITES			
1. Ships or Barges in Port or Drydock	SIP		MSF
2. Railroad Cars.	RRC		MSF
3. Trucks and Vans	TRV		MSF
4. Aircraft	ACF		MSF
5. Transportable Garbage Containers (Bumpsters)	TGC		EA

END OF CATEGORY II: OPERATIONS

CATEGORY 3--PESTICIDES

	DESCRIPTIVE TERMS	REPORT TERMS Col (f)
	Group I. INORGANIC INSECTICIDES AND ACARICIDES	
1.	Boric Acid Crystals	BRICACID
2.	Copper Sulfate Formulations	COPPERSULF
3.	Sulfur Dusts and Wettable Powders	DUSWETSULF
4.	Lime Sulfur	LIMESULFUR
5.	Lead Arsenate	LDARSENATE
6.	Paris,Green	PRISGREEN
7.	Silica Aerogels (Dry-Die)	SILICAAERO
8.	Silica Aerogel and Pyrethrins (Drione)	DRIONE
9.	Sodium Fluoride	SODIUMFLD
10.	Other Inorganic Insecticides and Acaricides	OII (add name)
	Group II. NATURAL ORGANIC AND BIOLOGICAL INSECTICIDES AND ACARICIDES	
1.	Pyrethrum (Including Synergized Formulations)	PYRETHRUM
2.	Pyrethrum and Silica Aerogel	DRIONE
3.	Rotenone, All Forms	ROTENONE
4.	Nicotine Compounds	NICOTINE
5.	Miscible Oils (Summer and Dormant)	MISCOIL
6.	Flit MLO	FLITMLO
7.	Oils, Minerals (Including Fuel and Diesel)	MINOILS
8.	Other Natural Organic Materials	ONA (add name)
9.	Milky Spore Oust (Bacillus popilliae)	MILKYSPORE
10.	Bacillus Thuringiensis (Thuricide, Dipel)	BACTHURING
11.	Mosquito Fish (Gambusia and Top Feeding Minnows)	MOSQFISH
12.	Other Biological Insecticides and Acaricides	OBI (add name)

DESCRIPTIVE TERMS	REPORT TERMS Col (f)
Group III. CHLORINATED HYDROCARBON INSECTICIDES AND ACARICIDE	
1. Aldrin	ALDRIN
2. Chlordane	CHLORDANE
3. ODT	DOT
4. Dieldrin	DIELDRIN
5. Heptachlor	HEPTACHLOR
6. Lindane	LINDANE
7. Benzene Hexachlor	BHC
8. Kelthane (Dicofol)	KELTHANE
9. Kepone.	KEPONE
10. Methoxychlor	MTHOXYCHLOR
11. Mirex	MIREX
12. Other Chlorinated Hydrocarbon Insecticides and Acaricides	OCH (add name)
Group IV. ORGANIX PHOSPHATE INSECTICIDES AND ACARDIES	
1. Abate	ABATE
2. Acephate (Orthene)	ACEPHATE
3. Aspon	ASPON
4. Diazinon	DIAZINON
5. Dichlorvos, DDVP, Vapona	DCHLORVOS
6. Dmethoate	DIMETHOATE
7. Dioxathion (Delnav)	DIOXATHION
8. Disyston (Disulfoton)	DYSTON
9. Metasystox-R	MTASYSTOX

DESCRIPTIVE TERMS	REPORT TERMS Col (f)
Group V. ORGANIC PHOSPHATE INSECTICIDES AND ACARICIDES	
10. Dursban (Chlorpyrifos)	DURSBAN
11. Fenthion (Baytex, Entex)	FENTHION
12. Malathion	MALATHION
13. Naled (Dibrom)	NALED
14. Ronnel (Korlan)	RONNEL
15. Aramite	ARAMITE
16. Mocap (Ethoprop)	ETHOPROP
17. Toxaphene	TOXAPHENE
18. Other Organix Phosphate Insecticides and Acaricides	OOR (add name)
Group VI MISCELLANEOUS INSECTICIDES AND ACARICIDES	
1. Allethrin (A Thiocyanate)	ALLETHRIN
2. Other Organic Thiocyanates	OOT (add name)
3. Permethrin (ambush)	PERMETHRIN
4. D-Phenothrin	D-PHENOTHRIN
5. Organic Sulfur Compounds	ORGANSULF
6. Chlorobenzilate (Acaraben)	CLROBENZIL
7. Resmethrin	RESMETHRIN
8. Baygon (Propoxur)	BAYGON
9. Carbaryl (Sevin)	CARBARYL
10. Ficam (Bendiocarb)	FICAM
11. Zectran (4-(dimethylamino)-3, 5-xylyl Methyl Carbamates	ZECTRAN
12. Other Carbamates	OCA (add name)
13. Other Synthetic Organic Insecticides and Acaricides	OSY (add name)

DESCRIPTIVE TERMS	REPORT TERMS Col (f)
Group VII. INSECT GROWTH REGULATORS AND INTERRUPTANTS	
1. Altosid (Methoprene)	ALTOSID
2. Disparlure	DISPARLURE
3. DIMILIN (Diflubenzuron)	DMILIN
4. Other Pheromones	OPH
5. Other Insect Growth or Metabolic Regulations and Interruptants (Biorationals)	OIGROWTHREG
Group VIII. NEMATOCIDES	
1. Dasanit (Fensulfothion)	DASANIT
2. MOCAP (Ethoprop)	ETHOPROP
3. NEMACUR (Fenamiphos)	NEMACUR
4. Sarolex (Diazinon)	DIAZINON
Group IX. RODENTICIDES, AVICIDES, AND RELATED MATERIALS	
1. Antigoagulants, Chronic (Warfin, diaphacinonek Pivalyn)	ANTICOAG
2. Talon (Frodificoum)	TALON
3. Maki (Bromadiolone)	MAKI
4. Chloro-phacinone (Rozol)	CHPHACIN
5. Calcium Cyanide	CACN
6. Glue Compounds (Sticky Boards)	GLUE
7. Norbormide (Raticate)	NORBORMIDE
8. Perching and Roosting Repellants	ROOSTREPEL
9. Red Squill	RSQUIL
10. Sodium Monofluoroacetate (1080)	1080
11. Strychnine	STRYCHNINE
12. Zinc Phosphide	ZNPH
13. Other Rodenticides	ORO (add name)
14. Gophacide	GOPHACIDE
15. Other Avicides	OVA (add name)

DESCRIPTIVE TERMS	REPORT TERMS Col (f)
Group X. FUMIGANTS AND RELATED MATERIALS	
1. Aluminum phosphide and Magnesium Phosphide (Phosphine)	PHOSPHINE
2. Carboxide	CRBOXIDE
3. Carbon bisulifide	CBISULFIDE
4. Hydrogen Cyanide	HCN
5. Methyl Bromide	MEBROMIDE
6. Paradichlorobenzene and Napthalene	PON
7. Sufficator Cartridges	SUFFICATE
8. Sulfuryl Fluoride (Vikane)	SULFURYLFL
9. Vapam (Metham-Sodium)	VAPAM
10. Other Fumigants and Related Materials	OFU (add name)
Group XI. FUNGICIDES AND WOOD PRESERVATIVES	
1. Benomyl (Tersan)	BNOMYL
2. Bordeaux Mixture (Fixed Copper)	BRDEAUX
3. Cadminate	CADMINATE
4. Captan	CAPTAN
5. Chloroneb	CHRONEB
6. Cycloheximide (Actidione)	CYCLOHEXIM
7. Daconil (Bravo, Chlorothalonil)	DACONIL
8. Dexon (Diazoben)	DEXON
9. Difolatan (Captafol)	DIFOLATAN
10. Dithane (M-45)	DITHANE
11. Dyrene (Anilzaine)	DYRENE
12. Ferbam	FERBAM
13. Folpet (Phaltan)	FOLPET
14. Karathane (Dinocap)	KARATHANE
15. Koban (Terrizole)	KOBAN
16. Kromad	KROMAD
17. Maneb	MANEB
18. Mancozeb (Fore)	FORE
19. Thiophanate Methyl (Fungo)	FUNGO
20. Thiram (Arasan)	THIRAM
21. Zineb	ZINEB
22. Other Fungicides	OFN (add name)
23. Creosote or Creosote-Tar-Mixtures	CREOSOTE

	DESCRIPTIVE TERMS	REPORT TERMS Col (f)
24.	Pentachlorophenol in Nonviolatile Oils	NONVPENTA
25.	Pentachlorophenol, Water-Repellent in Volatile Solvent	PENTAWAR
26.	Pentachlorophenol in Greases or Gels	PEGEL
27.	Other Wood Preservatives	OWO (add name)

Group XII. MISCELLANEWOUS PESTICIDAL COMPOUNDS

1.	Attractants	ATTRACTANT
2.	Repellents (For Insects, Mites, Ticks Only)	REPELLIMT
3.	Repellents, Other	OREPELLENT
4.	Metaldehyde (A Molluscicide)	METALDHYDE
5.	Sodium Carbonate (Molluscicide)	SDIUMCARB
6.	Sodium Chloride (A Molluscicide)	NACLMOLLUS
7.	Sodium Pnetachlorophenate (A Molluscicide)	NAPENTA
8.	Mesurol (Methiocarb) (A Molluscicide)	MESUROL
9.	Other Molluscicides	OMA (add name)
10.	Avitrol (4-Nitrophyridine-N-Oxide)	AVITROL
11.	Tribromoethanol (An Avicide)	TBE
12.	Starlicide	STARLICIDE
13.	Other Miscellaneous Materials	OMI (add name)

Group XIII. HERBICIDES PHENOXY-, CHLOROPHENYL-, PHENYLUREA, AND PICOLINI ACID COMPOUND

1.	2, 4-D (2,4-dichlorophenoxy acetic acid equivalent)	24D
2.	2, 4, 5-T (2,4,5-trichlorophenoxy acetic acid equivalent)	245T
3.	Diuron [3-(3, 4-dichlorophenyl)-1, 1-demethylurea](Karmex)	DIURON
4.	Fenuron (Dybar)	FNURON
5.	Monuron [3-(p-chlorophenyl)-1, 1- 1-demethylurea] (Telvar)	MONURON
6.	Monuron-TCA (UROX)	MOT
7.	Silvex, 2,4,5-TP [2-(4,5-trichlorophenoxy) propionic acid equivalent]	SLVEX
8.	Tebuthiuron (Spike)	TEBUTHIUR
9.	Picloram (potassium salt of 4-amino-3,5,6 -trichloropicolinic (acid)(Tordon)	PICLORAM
10.	Other Phenoxy-, Chlorophenyl-, Phenylurea, and Picolinic Acid Compounds	OPH (add name)

DESCRIPTIVE TERMS	REPORT TERMS Col (f)

Group XIV. HERBICIDES BENZOIC-, PORPIONIC-, AND TRICHLOROACETIC ACID COMPOUNDS

1.	TCA (trichloroacetic acid equivalent)	TCA
2.	Dalapon (2,2-dichloropropionic acid equivalent)	DALAPON
3.	Dicamba (Banvel)	DICAMBA
4.	Pronamide (Kerb)	PRNAMIDE
5.	Fenac	FNAC
6.	Other Benzoic-, Porpionic-, and Trichloroacetic Acid Compounds	OBE (add name)

Group XV. HERBICIDES, TRIAZINES, TRIAZOLES, HYDRAZIDES, AND DINITRO COMPOUNDS

1.	Amitrol (aminotriazole)(3 amino-1,2,4-triazole)	AMITROL
2.	Atrazine (2-chloro-4-ethylamino-6-isopropyl amino-s-triazine)	ATRAZINE
3.	Prometone (Pramitol)[2-Methoxy-4, 6-bis (isopropylamine)-s-triazine]	PROMETONE
4.	Simazine [2-chloro-4, 6-bis (ethylamino)-s-triazine](Princep)	SIMAZINE
5.	Maleic hydrazide (1,2-dihydropyridazine-3, 6-dione)	MLEICHYDRA
6.	Velpar (Hexazinone)	VELPAR
7.	Other Triazines, Triazoles, and Hydrazides	OTR (add name)
8.	Balan (Benefin)	BALAN
9.	Other Dinitro Compounds	DINITROCOM

Group XVI. HERBICIDES, INORGANIC, AND METAL-ORGANIC COMPOUNDS

1.	Copper Sulfate (Cutrine)	COPPERSULF
2.	Ammate (Ammonium Sulfamate)	AMMATE
3.	Arsneicals, Organic (DSMA)(MSMA)(Cacodylic Acid)	ARSENICORG
4.	Borate Compounds, Uncombined	BOR (add name)
5.	Chlorat Compounds, Uncombined	CLO (add name)
6.	Other Inorganic and Metal-Organic Herbicide Compounds	OIN (add name)

DESCRIPTIVE TERMS	REPORT TERMS Col (f)
Group XVII. MISCELLANEOUS HERBICIDES, ALGAECIDES, AND PLANT GROWTH REGULATORS	
1. Asulox (Methyl 4-amino benzene sulphonylcarbanate)	ASULOX
2. Bensulide (Betasan)[N-(2-mercaptolethyl) benesene sulfonamide S-(0, 0-diisopropyl phosphorodiathioate)	BENSULIDE
3. Bromacil (5-bromo-3-sec-butly-6 methyluracil)(Hyvar)	BROMACIL
4. Diquat (1,1-ethylene-2, 2-dipyridilim)	DIQUAT
5. Paraquat	PARAQUAT
6. DCPA (Dacthal)(Dimethyl tetrachlorotere-phtalate)	ENDOTHALL
7. Oil, Herbicidal	HERBOIL
8. Tandex (Karbutilate)	TANDEX
9. Casoron	CASORON
10. Glyphosate (Round-up)	GLYPHOSATE
11. Other Herbicides, Uncombined	OUN (add name)
12. Maintain (MH-30), Maleic Hydrazide	MLEICHYDRA
13. Chlorflurecol (maintain-A)(CF-125)	CHFLURECOL
14. Embark (An Acetamide Compound)	ACTAMIDE
15. Other Plant Growth Regulators	PGR (add name)

DESCRIPTIVE TERMS	REPORT TERMS	
	Col (g)	Col (i)
		Use Columns

Group XVIII. DRY FORMULATIONS

1.	Dusts	DUS	PDW
2.	Granules and pellets	GRN	PDW
3.	Solid Fumigants (Include Dichlorvos Strips and Pellets)	SFU	PDW
4.	Baits	BTS	PDW
5.	Briquettes (for Slow Release Pesticides)	BQT	PDW
6.	Other Dry Pesticide Forms (Include Toss Its)	ODP	PDW

Group XIX. LIQUID, PASTES, GREASES, GASSES, AND MISCELLANEWOUS FORMULATIONS

1.	Emulsions	EML	ZGL
2.	Solutions	SLN	ZGL
3.	Suspensions	SUS	ZGL
4.	Liquid Fumigants and Liquidified Gasses	LFU	PDW
5.	Pastes and Greases Include Invert Emulsions)	POG	PDW
6.	Aerosols	AER	FLO
7.	Other Liquid Forms	OLP	ZGL

END OF CATEGORY II: OPERATIONS

Sample Letter to Fire Marshall

LETTERHEAD

OFFICE SYMBOL DATE

MEMORANDUM FOR Fire Marshall, Directorate of Public Works, Fort Anywhere, Texas XXXXX-XXXX

SUBJECT: Storage of Toxic materials

1. The Pest Management Section, Facilities Engineer, Fort David Crockett, Texas, has the responsibility of providing pest control on this installation. Because of this responsibility it is necessary to store a quantity of toxic, flammable materials on this installation. It is recommended that the information provided below be disseminated to all members of your staff so that appropriate protective measures could be taken in the event of a fire or explosion.

2. Location of Toxic Material, Building 1532

   a. Type of Building Construction--wood with asphalt roof

   b. Nearest Unoccupied Building--50 feet

   c. Nearest Occupied Building--200 feet

   d. Building located on corner of Travis and Houston Street at intersection of Service Road #2

   e. Nearest fire hydrant--300 feet south

   f. Floor plan of storage area enclosed

3. Materials Stored in Building

   a. Insecticides, both oil base and dusts

   b. Herbicides, both oil base and dusts

4. Hazards

   a. Toxic smoke

   b. Material may be absorbed through skin

   c. Explosions

5. Recommend the following protective equipment for firefighters in the event a fire should occur in Building 1532:

   a. Protective masks for organic vapors

   b. Supplied air masks if entering building

   c. Protective outer garments to prevent absorption of toxicant through the skin

6. Request you perform an informal inspection of Building 1532 if any additional information concerning the nature of the toxicants stored is necessary. Mr. D. Boone, Chief, Pest Management Section, can be contacted at xxx-42076.

encl
(fioor plan)

DANIEL BOONE
Chief, Pest Management Section
DEH

Sample Letter to Director of Medical Activities

OFFICE SYMBOL DATE

MEMORANDUM FOR Commander, Installation Medical Activities, Fort Anywhere, Texas XXXXX-XXXX

SUBJECT: Use of Toxic Materials

1. The Pest Management Section, Facilities Engineer, Fort David Crockett, Texas, is charged with the responsibility of pest control at this installation. It is necessary to store and use quantities of toxic chemicals in order to accomplish this mission. Although the pest management personnel take normal protective precautions, i.e., face masks, protective clothing, etc., to prevent exposure, potential poisoning incidences could occur. The information given below is provided so that you might be better prepared to render the appropriate treatment in the event a poisoning incident should occur.

2. Toxic materials normally used by this activity include

a. Organic phosphate insecticides. such as--(list those appropriate)

b. Chlorinated hydrocarbon insecticides--(list those appropriate)

c. Organic sulfur insecticides--(list those appropriate)

d. Petroleum products--(list those appropriate)

e. Herbicides--(list those groups and types appropriate)

3. Possible routes of poisoning. The usual routes of poisoning for these materials could be absorption through the skin, inhaled, or ingested

4. Recommend appropriate literature on the treatment of pesticide poisoning be procured and available at the dispensary (indicate the facility normally visited by civilian personnel)

5. Recommend the treatment staff (list the appropriate treatment facility) be advised of the toxic materials normally used in pest management operation so that they might recognize symptoms and provide more speedy treatment in the event a poisoning accident should occur.

DANIEL BOONE
Chief, Pest Management Section
DEH

EXERCISES, LESSON 2

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. The permanent historical record of pest control operations and pesticides for each building, structure, or outdoor site on all Army installations is recorded on the DD Form _____, _____

_____

2. The form used by the installation engineer to report all pesticide use and pest control operations is DD Form _____, _____

_____

3. List the six primary purposes for maintaining records and reports.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

4. A list of the possible routes of poisoning and any peculiar properties of pesticides such as reactivity, volatility, and flashpoint should be provided in a letter to the installation

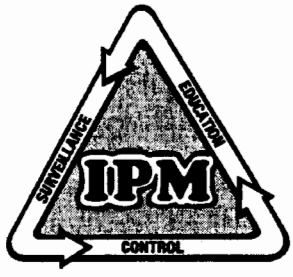
_____

5. The annual review of records can be used to _____

_____

_____

END OF LESSON EXERCISES



	LESSON ASSIGNMENT
LESSON 3	Integrated Pest Management.
LESSON ASSIGNMENT	Paragraphs 3-1 through 3-19.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to employ integrated pest management IAW AR 420-76, AFPMB *Military Pest Management Handbook*, TIM 28, and Flint, *Introduction to Integrated Pest Management*.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 3-1. Identify the DoD definition of integrated pest management. 3-2. Identify the appropriate type of pest control for a particular situation. 3-3. Identify the components of an integrated pest management program.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

INTEGRATED PEST MANAGEMENT

Section I. GENERAL INFORMATION

3-1. INTRODUCTION

a. History. Man has been plagued by pests of one type or another since his earliest beginnings. Early man was primarily a nomadic forager. His pest problems would have been of a personal nature with mosquitoes, lice, fleas, and flies causing personal discomfort. He dealt with these problems by slapping, picking, and squashing the offending insects. With the development of agriculture and permanent settlements, man encountered new problems brought about by the concentration of people in one location, monoculture crop production, and the storage of large amounts of food.

b. Evolution of Pest Control. Early pest control practices were often based on superstition and folklore. These early practices gradually evolved through a process of trial and error. Around 2500 B.C., the Sumerians were using sulfur compounds to control insects. The Chinese developed biological fumigants and insecticides as early as 1200 B.C.. As man continued to gain knowledge about his environment and the organisms living in it, his methods for controlling them also evolved.

3-2. THE SEARCH FOR COMPATIBLE PEST CONTROL MEASURES

a. Synthetic Pesticides. The advent of DDT and other synthetic pesticides during the

1940's diverted attention from many of the nonchemical control measures previously employed. The new chemicals were easy to apply and initially so effective and inexpensive that they appeared to be the ultimate tool for pest eradication. Because recognition of their shortcomings was slow to surface, pesticide usage increased dramatically until pesticides became the primary control tool for pests of all kinds.

b. The Need for New Pest Control Measures. Overdependence on chemicals introduced many problems such as:

- Pesticide resistance.
- Destruction of natural controls.
- Environmental contamination.
- Health hazards.

Consequently, we now find ourselves searching for safe, efficient, economic, and environmentally compatible pest control measures which can be employed without generating new problems. The solutions are often superior to any application of pesticides alone.

Section II. INTEGRATED PEST MANAGEMENT (IPM)

3-3. IPM DEFINED

Integrated pest management is an ecologically based pest management strategy. IPM uses pesticides, but only after systematic monitoring of pest populations and natural control factors indicates a need.

- Ideally, an integrated pest management program considers all available pest control actions, including no action.
- IPM evaluates the potential interaction among various control tactics, cultural practices, weather, other pests, and the system to be protected.

IPM CONSIDERATIONS AND EVALUATIONS

- Consider: all available pest control actions, including no action.
- Evaluate:
  - -- Potential interaction among various control tactics.
  - -- Cultural practices.
  - -- Weather.
  - -- Other pests.
  - -- The system to be protected.

3-4. "PEST" DEFINED

a. Definition. The definition of "pest" is a totally human oriented concept. Organisms that compete with people for food, fiber, and shelter; feed on people; transmit pathogens; or otherwise threaten human health comfort or welfare, either real or perceived, are termed pests.

PESTS--DEFINED BY HUMANS

Organisms that:

- Compete with people for food, fiber, shelter.
- Feed on people.
- Transmit pathogens.
- Threaten human health, comfort, or welfare (real or perceived).

b. Variety of Organisms Termed "Pests." Organisms that have become pests are not limited to any specific class, phylum, or even kingdom. They are as varied as the habitats that they inhabit. Arthropods are most frequently defined as pests, with other invertebrates, vertebrates (e.g., rats, coyotes, deer, birds), microogransims (e.g., bacteria, fungi, protozoa, virus), and plants thrown into the mix.

3-5. THE DoD PEST MANAGEMENT OBJECTIVE

The objective of the DoD pest management program is to manage pests which could adversely affect operations, health, or destroy property and to do so within FIFRA guidelines.

3-6. THE DoD DEFINITION OF IPM

IPM is defined as the use of all appropriate technological and management techniques to bring about an effective degree of pest prevention and suppression in a safe, cost-effective, environmentally sound manner.

Section III. TYPES OF CONTROL

3-7. CHOOSING A METHOD OF CONTROL

Integrated pest management programs employ a variety of strategies, to obtain effective, long lasting control in the least disruptive manner to the environment.

a. Pest Control Methods. These strategies can be categorized into the six methods of control. Each method of control may be used by itself or in combination with one or more other control measures to obtain the most effective integrated pest management program for a particular pest.

METHODS OF PEST CONTROL

- Biological control
- Mechanical control
- Physical control
- Regulatory control
- Cultural control
- Chemical control

b. Choosing a Method. When choosing a method of control, the pest management professional first needs to thoroughly evaluate the pest problem. The evaluation should include but not be limited to:

- Pest surveillance to determine population size.
- Physical environment.
- Cultural environment.
- Biological environment.

3-8. BIOLOGICAL CONTROL

a. Biological Control Considerations. Biological control can be considered in several aspects: existing biological limitations; natural predators and competitors; genetic engineering; and introduction of predators.

(1) The pest's ecosystem. When assessing a pest problem, it is very important to observe the pest's ecosystem in detail to determine how to best control the problem.

(2) Exotic pests. A pest often becomes a pest due to the absence of its natural predators or competitors. Many pests were imported into the country for a purpose only to escape or be released and find a niche that they could exploit (e.g., gypsy moth). Still others arrived as immigrants. They outcompete existing organisms and become pests (e.g., kudzu and imported fire ants).

b. Forms of Biological Control. The use of biological control can take many forms and be very beneficial. Biological control usually does not eradicate pest populations. However, biological control often provides long-term environmental suppression of the populations to acceptable levels.

(1) Irradiation. Irradiated male flies may be released to breed with wild female flies, thereby producing infertile eggs and reducing the fly population. This is also sometimes considered a form of physical control.

(2) Natural enemies. The introduction of natural parasites and predators may be very effective for control of exotic pests. Introduction of host specific insects has also

been very useful for control of exotic weeds. However, care must be taken with this strategy. Introduction of general predators has had serious environmental impact (e.g., decimation of island bird populations following the introduction of predators to control rats).

(3) Species-specific pathogen. Another method of biological control is the introduction of a species-specific pathogen delivered either by application or by a vector. The purpose is to control an exotic species in the absence of natural predators.

(4) Insect growth regulators. Insect growth regulators have also been used to control the growth of larval insects thereby limiting the number that reach maturation and are able to reproduce.

(5) Pheromone traps. Pheromone traps are used extensively both as a surveillance tool and a biological control for stored product pests and agricultural pests.

3-9. MECHANICAL CONTROL

This is a direct control measure. Pests are removed or killed by the use of mechanical devices and traps. Screens are used on windows, doors, and vents to keep pests out. Wire is used to eliminate bird roosts on buildings. This type of control also includes construction of structures to exclude pests and the maintenance and repair of existing structures to eliminate pest harborage.

3-10. PHYSICAL CONTROL

Physical control is the use of energy factors in the environment (heat, cold, light, sound) to kill pests or attract them to a killing mechanism. Physical control can involve temperature manipulation. Cold storage is used to control stored products pests. Light traps are used to attract insects to a killing device (electric grid or sticky paper). Certain animals have aversions to certain sounds (high decibels pitch or cries) that can be used to repel pests.

PHYSICAL CONTROL METHODS

- Cold storage
- Light traps
- Sound

3-11. REGULATORY CONTROL

a. Regulations and Laws. Regulations and laws are used to eradicate, prevent, or restrict infestations. This type of control has been used against coyotes, wolves, brown tree snakes, gypsy moths, and many others. Regulations can mandate the measures to be taken to prevent the spread of a pest from one area to another. Sometimes these measures are extreme in that some products (e.g., grains, fruits, etc.) cannot be shipped from certain areas due to a pest infestation. While this may seem drastic, it is highly effective in controlling the spread of numerous agricultural pests.

b. International Regulatory Control. The DoD also deals with international regulatory control issues during deployments and redeployment. Host nation import regulations as well as US laws must be considered during support and sustainment operations (previously known as "operations other than war"). Developing a protocol for the cleaning and inspection of equipment and vehicles and any other items may be required.

3-12. CULTURAL CONTROL

a. Definition. Cultural control is the careful, nonchemical changing of the environment to make it less favorable for a particular pest. This type of control includes: sanitation, habitat modification, and education. Cultural control also includes the removal or destruction of breeding, harborage, and overwintering habitats of pests.

b. Education of Population. Pest problems are often due to poor sanitation practices which are the result of a lack of education. It is possible to clean up an area

through habitat modification or removal of trash and brush, only to have the problem return over time. Education of the local population about the cause of the pest problem is the only long term solution of preventing recurrence.

c. Subtle Problems. Cultural problems are often not as clear cut as a large pile of garbage. They are often as subtle as eating lunch at one's desk or keeping snacks in desk drawers. Crumbs left from lunch or open packages of food in a drawer will attract various pests. The removal of the food source and a thorough cleaning of the area will often eliminate the pest without the need for chemical control measures.

3-13. CHEMICAL CONTROL

Chemical control is reduction of pest populations or prevention of insect injury by using chemicals to poison them, attract them to other devices, or repel them from specific areas. Chemical control includes the use of pheromones, insect growth regulators, repellents, etc.

- This type of control is discussed last to emphasize that other forms of control should be considered first, whenever possible.
- This is not to say that chemicals should be applied only as a last ditch effort, but that they should not be considered as the first choice for control without a thorough examination of the problem.

REMEMBER

Consider chemical control
only
after you have thoroughly
examined the problem
and eliminated other means of control.

Section IV. DEVELOPMENT OF AN INTEGRATED PEST MANAGEMENT PROGRAM

3-14. DECISIONS BY PROFESSIONALS

Integrated pest management requires professional attention. The people making integrated pest management program decisions must have a biological and ecological background. They must be able to adequately assess all aspects of a pest problem. Then they need to design and implement an integrated pest control program to reduce the pest population to an acceptable level.

3-15. NECESSITY OF INTEGRATED PEST MANAGEMENT

The need for IPM programs is clear when we look at increased pesticide resistance, pest resurgence, the increase of secondary pests, the hazards pesticides pose to man and the environment, and the escalating cost of pesticides. On first impression, it would seem that rapid and wide scale implementation of integrated pest management is inevitable. This premise has been around for at least 15 years, yet today the use of IPM programs is still limited.

3-16. CONSIDERATIONS FOR IMPLEMENTATION OF IPM

a. Holistic Approach. Integrated pest management is a holistic approach in dealing with a pest problem.

- The pest problem is first examined in depth to determine if the pest is really a problem.
- Where and when is the pest a problem?
- This information must be obtained before determining appropriate control measures for an IPM program.
- Sometimes the target pest is only a perceived problem, and education may be required.

- Other pests may only warrant control measures if the damage (economic or personal) reaches a certain threshold level.

b. Examine the Effectiveness of the Control Approach. As pest populations reach threshold levels, then the efficacy of control needs to be examined closely: Is it practical and cost effective? The ease of implementation and the implementation of the least disruptive program need to be considered.

c. Long Term Control vs. Temporary Control. Finally, is the problem a long term problem or a temporary problem? If the problem is long term, then steps need to be taken to correct the problem and not just treat the symptoms. If the problem is temporary, then it may require less drastic measures.

d. Determination of Threshold Level and the Role of the Pest Management Professional. The determination of threshold level has no set formula or number. It can be based on one or several factors:

- Economic loss.
- Loss of man hours due to injury or disease.
- Nuisance and annoyance factors.
- Etc.

(1) Role of the pest management professional (PMP). The role of the pest management professional is to determine the threshold level for each pest encountered. Once the pest has reached the threshold limit, the PMP determines what control measures are going to be implemented.

(2) Education. Often an individual's threshold limit for pest problems is "none." "None," however, is not practical. Education may reduce this personal pest annoyance factor.

3-17. COMPONENTS OF IPM

Integrated pest management relies on:

- Gathering data.
- Monitoring.
- Establishing threshold levels.
- Precise record keeping.
- Determination of the least toxic treatments.
- Continued monitoring and evaluation.
- Education.

The implementation of all these components results in a working integrated pest management program. Education should be the comerstone of all pest management programs, but it is often the least used component.

3-18. THE INTEGRATED PEST MANAGEMENT PROFESSIONAL

As the integrated pest management professional, you are responsible for educating your customers about pest problems. When people understand pest problems, the different control options, and the ramifications of control measures, you will be able to fully implement a functional integrated pest management program.

3-19. DoD POLICY

It is the policy of the DoD to establish and maintain safe, efficient, and environmentally sound integrated pest management programs to prevent or control pests that may adversely affect health or damage structures, materials, or property.

EXERCISES, LESSON 3

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. What is the DoD policy regarding integrated pest management programs?

_____

_____

_____

_____

2. The DoD definition of integrated pest management is _____

_____

_____

_____

3. List the six methods of pest control discussed in this lesson.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

4. List four problems caused by overdependence on chemicals for pest control.

a. _____

b. _____

c. _____

d. _____

5. The importation of the kudzu vine to prevent soil erosion in the southeastern United States is an example of _____ control which in turn has become a pest.

6. Five forms of biological control are:

a. _____

b. _____

c. _____

d. _____

e. _____

7. Wire to eliminate bird roosts on buildings is a form of _____ pest control.

8. An electric grid or sticky paper used to attract insects is a method of _____ pest control.

9. What is cultural pest control? _____

_____

_____

_____

10. At what point would a pest management professional consider chemical control of a pest problem? _____

_____

_____

_____

_____

11. List five basic parts of an integrated pest management program.

a. _____

b. _____

c. _____

d. _____

e. _____

12. For the individual whose threshold limit for a pest problem is "none," the solution is _____

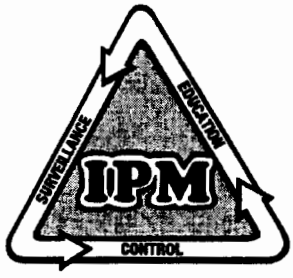
_____

_____

_____

_____

END OF LESSON EXERCISES



	LESSON ASSIGNMENT
LESSON 4	Installation Pest Management Plans.
LESSON ASSIGNMENT	Paragraphs 4-1 through 4-10.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to prepare an installation pest management plan IAW AR 40-5, AR 420-76, AR 200-1, and DoD Directive 4150.7.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 4-1. Identify the regulation/directive that requires the establishment of an installation pest management program. 4-2. Identify the appropriate component to the pest management regulation or directive. 4-3. Identify the responsibilities of pest management positions. 4-4. Identify the elements of policy guidance for an installation pest management plan. 4-5. Select the basic requirements for an installation pest management plan.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 4

INSTALLATION PEST MANAGEMENT PLANS

Section I. REQUIREMENTS AND RESPONSIBILITIES

4-1. INTRODUCTION

The installation pest management plan describes all pest management requirements for an installation and satellite sites. This document is required by AR 420-76, Pest Management. The Installation Pest Management Plan is a "living document", that gives direction and form to the pest management program on an installation, and ensures that negative environmental and health impacts are minimized. It should be useful to pest controllers and other installation personnel and be reviewed and updated annually to ensure information is current.

4-2. REQUIREMENTS FOR INSTALLATION PEST MANAGEMENT PLANS

a. General Requirements. The requirement for the establishment of a IPMP is

found in DoD Directive 4150.7, DoD Pest Management Program.

- The plan should list all program objectives arranged in order of priority according to potential or actual impact on health, morale, structures, material, and property.

- The plan identifies the productive manpower requirements for pest management and is the basis for the installation pest control staff size.

b. Pest Management Programs. Chapter 3, AR 420-76, requires the establishment and maintenance of Installation Pest Management Programs with the most efficient organization as a part of the installation real property maintenance program.

- The plan will list all program objectives in order of priority, according to the potential or actual impact on health, morale, structures, or property.

- These programs will be managed by professional pest management personnel or certified pesticide applicators to minimize or eliminate adverse environmental effects.

4-3. RESPONSIBILITIES

a. MACOM Pest Management Consultant. The MACOM Pest Management Consultant is responsible for the following:

(1) Advises. Advises on all aspects of pest management operations to include manpower requirements, operational needs, minimizing environmental impact, training and certifying pest management personnel, and procedures needed to assure efficient pest control programs.

(2) Maintains records/certifies personnel. Maintains records of training and certification status of pesticide applicators and checks their activities to determine competence. Certifies pest management personnel in accordance with the DoD Plan for Certification of Pesticide Applicators.

(3) Reviews/approves. Reviews and approves installation pest management plans. Reviews and approves technical provisions of all pest management contracts before soliciting bids.

b. The Installation Commander. The installation Commander is responsible for designating a pest management coordinator for all installation pest management activities and for approval and support of the installation's pest management plan.

c. The Directorate of Engineering and Housing or Directorate of Public Works. The DEH or DPW is responsible for the following:

- Prepares a pest management plan for all areas within the installation's responsibilities.

- Ensures that pest management personnel receive adequate training to achieve required pest management certification.

- Assures that all pest management operations are done safely.

- Performs all recordkeeping and reporting requirements IAW AR 200-5.

- Assures that pest management operations are conducted so as to minimize any adverse effects on the environment.

Section II. COMPONENTS OF THE PLAN

4-4. BASIC REQUIREMENTS

The plan will list all program objectives arranged in order of priority according to the potential or actual impact on health, morale, structures, or property. In general, the priority should be:

- Control of disease vectors and reservoirs of medical importance.
- Control of pests that damage or destroy stored products, beneficial plants, or undesirable plants.

The MACOM PMC has the authority to rearrange these priorities where local conditions necessitate such changes.

4-5. STAFFING REQUIREMENTS

Staffing requirements to accomplish the pest management workload will be identified and will ensure the most economical staffing and maximum use of personnel. The minimum staffing requirements will be attached as an appendix to the basic plan.

4-6. PROJECTED IN-HOUSE VS. COMMERCIAL CONTRACT COSTS

Pest control functions that can be accomplished more economically through commercial contracts shall be identified. An analysis showing the cost comparison shall be attached as an appendix to the plan.

4-7. SEPARATE WORKSHEET FOR EACH PEST

A separate worksheet will be prepared for each pest and will be updated annually. Integrated pest management techniques should be stressed.

NOTE: See Figure 4-1 for proper format for a worksheet.

4-8. APPENDICES TO THE PLAN

The following may be included as appendices to the plan:

- Installation map and description of the natural history and geology of the area.
- Pesticide and application equipment inventories.
- MSDS and/or labels for pesticides used on the installation.
- Emergency telephone numbers (e.g., Police and Fire Departments, Chemtrac, CHPPM Pesticide Hotline).
- Points of contact include installation personnel; MACOM PMC; support CHPPM activity; land grant university extension service; Mosquito Abatement District; state Department of Public Health.
- List of pest controllers, with certification numbers and expiration dates of the Certificates of Competency; pesticide spill SOP.

4-9. PEST MANAGEMENT CONSULTANTS

Pest Management Consultants shall give special attention to any pesticide application that:

- Uses a restricted-use pesticide or uses any pesticide that may significantly contaminate surface or ground water.
- Includes 259 or more contiguous hectares (640 acres) in one pesticide application.
- May adversely affect endangered or other protected species or habitat.
- Involves aerial application of pesticides.

4-10. IPM BASIC REQUIREMENTS

- ✓ Control disease vectors and reservoirs of medical importance.
- ✓ Control stored products pests.
- ✓ Control pests that damage/destroy beneficial plants.

PEST MANAGEMENT WORKLOAD DEFINITION WORKSHEET

A. Objective (what and why).

1) Target pest, life stage (s).

2) Purpose of management.

B. Surveillance (who, how, where and when).

1) Responsible organization official.

2) Techniques and procedures.

3) Location or locations (specify).

4) Schedule.

C. Treatment or control to be applied (who, how, where, and when).

1) Responsible official.

2) Nonchemical controls (e.g., biological, cultural or mechanical).

a) Type

b) Method of application

c) Treatment (preventive or corrective)

d) Location(s) to be treated (for each specific site include units to be treated, number of applications, criteria that trigger pesticide applications, schedule of treatment and climatic conditions).

3) Pesticides.

a) Common name

b) EPA Registration Number

c) Formulation

d) Concentration of active ingredient

e) Source or NSN

Figure 4-1. Pest Management Workload Definition Worksheet (continued).

f) Application data

1) Finished formulation

2) Use strength

3) Diluent

4) Rate (for example, pounds per acre).

5) Method of dispersal

6) Treatment (preventive or corrective)

D. Sensitive areas to be treated with caution or avoided.

E. Special health and safety measures required.

F. Any control procedures that require MACOM PMC approval or coordination with the AFPMB.

G. Remarks (e.g, special disease vector control requirements).

H. Personnel requirements for prevention or control of the target pest based upon the program detailed above (include the method used to identify the personnel requirement).

Figure 4-1. Pest Management Workload Definition Worksheet (concluded).

EXERCISES, LESSON 4

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. The document that requires an installation pest management plan is AR, _____

_____

2. The "living document" that gives direction and form to the pest management program on an installations is the _____

_____

3. The responsibility for maintaining a record of training and certification status of pesticide applicators as well as checking their activities to determine competence is the _____

_____

4. Assuring that pest management operations are conducted so as to minimize any adverse effects on the environment is the responsibility of either the Directorate of _____ or the Directorate of _____.

NOTE: The two letters at the end of this lesson are the documents which drive integrated pest management plans.

5. The program objectives in order of priority of a pest management plan are:

a. _____

_____

b. _____

_____

c. _____

_____

6. Three basic requirements for an installation pest management plan are:

a. _____

_____

_____

b. _____

_____

c. _____

_____

END OF LESSON EXERCISES

ACADEMY OF HEALTH SCIENCES
PREVENTIVE MEDICINE DIVISION

GR 72-198-820-1
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DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington, DC 20314

DAEN-MPO-B

Technical Note
No. 80-1

19 November 1979

FACILITIES ENGINEERING
Maintenance and Repair

INTEGRATED PEST MANAGEMENT PROGRAM

1. Purpose. To provide guidance on the initiation and maintenance of an integrated pest management (IPM) program.

2. Applicability. This technical note applies to all facilities engineering elements responsible for real property maintenance activities at installations within the purview of AR 420-10.

3. Discussion.

a. President Carter, in his Environmental Message of August 2, 1979, emphasized the need to encourage IPM in the operational programs of federal agencies because of the economic and environmental benefits. The President directed that pest management programs be:

(1) Modified to support and adopt IPM strategies wherever practicable within the limits of existing resources.

(2) Reviewed to assess the potential for increased emphasis on IPM.

b. The existing Army policy also places emphasis on IPM. Paragraph 2-14 of AR 420-76 states "Department of the Army installations will utilize IPM methods in their pest management programs to the maximum extent possible."

c. Basically IPM is a system which utilizes any suitable pest control technique or method to reduce pest populations to an acceptable level. Chemical control which has long been the major pest control method, has recently become a sensitive issue. Use of IPM will not totally replace chemical pesticides but the hazards, risks, and costs associated with pesticides should be significantly reduced. IPM is based on a thorough knowledge of both the site (structures, personnel, plants, etc.) and the pests. With this base, a simple common sense management procedure follows:

(1) Correctly identify the problem and the pest(s) responsible.

(2) Determine all available management and control alternatives.

(3) Choose the safest, most economical and efficient solution.

(4) Time control and management techniques to achieve maximum beneficial results.

d. In order to effectively improve upon the application and practice of IPM in operational pest management programs, the following procedures should be followed:

(1) Use Chapter 2, Section 3 of TM 5-632 as a guide in modifying existing pest management programs to include improved utilization of IPM principles.

(2) Review the various types of control methods illustrated on the inclosure when determining alternatives available. It must be understood that all control methods listed for a particular pest may not be applicable or effective for each situation. When help is needed in determining proper available control measures, assistance should be obtained from appropriate professional pest management personnel.

FOR THE CHIEF OF ENGINEERS:

1 Inc
as

ROBERT B. McGOUGH
Acting Chief, Operations and
Maintenance Division
Directorate of Military Programs

THE OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
Washington, D.C. 20301-8000

PRODUCTION AND
LOGISTICS

MEMORANDUM FOR DEPUTY ASSISTANT SECRETARY OF THE ARMY (ENVIRONMENT, SAFETY AND OCCUPATIONAL HEALTH), OASA (I.L&E)
DEPUTY ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS AND HOUSING), OASA (I, L&E)
DEPUTY SECRETARY OF THE NAVY (ENVIRONMENT AND SAFETY), OASA (I&E)
DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (ENVIRONMENT, SAFETY AND OCCUPATIONAL HEALTH), SAF/MIQ
DIRECTOR, DEFENSE LOGISTICS AGENCY (DLA-W)

SUBJECT: Integrated Pest Management (IPM)

I am writing to place a renewed emphasis on IPM as policy in our DoD Pest Management Program. IPM is the use of all appropriate technology and management practices to bring about pest prevention and suppression in a cost-effective, environmentally sound manner. This does not mean the elimination of pesticides, nor an emphasis on these chemicals. They must be used with discrimination, rather than as the item of choice.

Nearly 30 years ago, Rachael Carson wrote "Silent Spring", and constraints on pesticides became the vanguard of the environmental movement. Many additional environmental problems, which demand our attention and action, have surfaced since that time. However, we must remember that pesticides are still relatively unique as toxic contaminants, in that we must purposely put them into our environment for them to work. Therefore, the user has a special responsibility to be fully knowledgeable on the impact of these chemicals and to use preventive, nontoxic or least toxic alternatives on a priority basis on our installations.

This IPM policy applies to contract, as well as in-house, pest management operations. We are looking for the best value, both environmentally and economically, not just short term results. The Armed Forces Pest Management Board (AFPMB) is currently developing expanded guidance on IPM techniques which will be forwarded to you. As this renewed emphasis on IPM evolved, I ask your continued full participation at all levels in demonstrating the leadership which DoD has shown in its Pest Management Program.

Please direct questions or comments to COL Robert M. Clegern, USAF, AFPMB Executive Director, at DSN 291-5191 or (301) 427-5191.

Thomas E. Baca
Deputy Assistant Secretary of Defense
(Environment)

THE SECRETARY OF DEFENSE
WASHINGTON, THE DISTRICT OF COLUMBIA

19 OCT 1989

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS

SUBJECT: Environmental Management Policy

This Administration wants the United States to be the world leader in addressing environmental problems and I want the Department of Defense to be the Federal leader in agency environmental compliance and protection.

Federal facilities, including military bases, must meet environmental standards. Congress has repeatedly expressed a similar sentiment. As the largest Federal agency, the Department of Defense has a great responsibility to meet this challenge. It must be a command priority at all levels. We must demonstrate commitment with accountability for responding to the Nation's environmental agenda. I want every command to be an environmental standard by which Federal agencies are judged.

The first priority of our environmental policy must be to integrate and budget environmental considerations into our activities and operations. This will decrease our future liabilities and costs for our people. The effort begins and ends with our people. We need the right people at the right place with the right training.

It is also extremely important that we communicate clearly what we are doing to address our environmental concerns. We need to work harder at telling our environmental success stories and solving our problems in an open, cooperative way with the public and also appropriate regulatory authorities. The universal recognition of effective DoD environmental compliance and stewardship activities is the surest way to maintain our access to the air, land, and water we need to maintain and improve our mission capability.

We must be fully committed to do our part to meet the worldwide environmental challenge and I know I can count on your support to ensure that we are successful in that effort.

Signature block
Dick Cheney
Secretary of Defense

LESSON ASSIGNMENT

LESSON 5	Introduction to Arthropods.
LESSON ASSIGNMENT	Paragraphs 5-1 through 5-15.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to identify an organism as an arthropod IAW *Herms Medical Entomology* and the *AFPMB Military Pest Management Handbook*.
SPECIFIC LESSON OBJECTIVES	After completing this lesson, you should be able to:

5-1. Describe scientific nomenclature.

5-2. Identify characteristics common to all arthropods.

5-3. Identify the three body regions of insects.

5-4. Identify the following features of the insect head:

Mouth.
Antennae.
Compound eyes.
Simple eyes.

5-5. Identify the following insect mouthparts:

Labrum.
Mandibles.
Maxillae.
Labium.
Hypopharynx.

5-6. Describe the following types of mouthparts:

Chewing mouthparts.
Sponging mouthparts.
Piercing-sucking mouthparts.

5-7. Identify the following features of the insect thorax: wings, legs, and spiracles.

SPECIFIC LESSON OBJECTIVES (continued)

5-8. Describe the following types of insect metamorphosis and give examples of each:

- Aemetamorphosis.
- Gradual metamorphosis.
- Incomplete metamorphosis.
- Complete metamorphosis.

5-9. Give the identifying characteristics of the following arthropod classes:

- Insecta.
- Arachnida.
- Diplopoda.
- Chilpoda.
- Crustacea.

SUGGESTION

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 5

INTRODUCTION TO ARTHROPODS

Section I. ARTHROPOD CLASSIFICATION

5-1. INTRODUCTION

The Phylum Arthropoda is the largest group of animals on earth. Many are beneficial and even essential to human culture and survival. However, there are arthropods that compete with us for our resources. Others can injure us directly through their biting and stinging activity, and indirectly by serving as vectors of disease organisms. Knowing something of arthropod morphology, physiology, and life cycles provides information we can use to control them.

5-2. COMMON NAMES

We give names to organisms with which we are familiar. This is particularly true for organisms that compete with us or injure us, as well as those that have value to us. While common names are useful for classifying and visualizing arthropod groups and individual species, there are practical problems with this nomenclature. Common names often do not uniquely identify phylogenetically related groups. They may be shared by more than one species; they may be regional; and the same species may have more than one common name. For example, sandfly is commonly used to refer to any number of small, unrelated biting flies.

5-3. SCIENTIFIC NOMENCLATURE

a. General. Because of the problems associated with common names, science uses a set of universally recognized rules (scientific nomenclature) to classify all living organisms. Scientific nomenclature is based on grouping phylogenetically related organisms. It assigns unique names to related groups, ultimately giving a single, unique scientific name to individual species. While common names are acceptable under most circumstances, it is useful for pest managers to be familiar with basic scientific classification and the use of scientific names. Table 5-1 shows a comparison of the scientific classification for humans, the house fly, and the dandelion.

CLASSIFICATION	HUMANS	HOUSE FLY	DANDELION
Kingdom	Animal	Animal	Plant
Phylum	Chordata	Arthropoda	Spermatophyta
Class	Mammalia	Insecta	Dicotyladoneae
Order	Primata	Diptera	Campanulades
Family	Hominidae	Muscidae	Compositae
Genus	*Homo*	*Musca*	*Taraxacum*
Species	*sapiens*	*domestica*	*officinale*

Table 5-1. Scientific classification for humans, the house fly, and the dandelion.

b. Genus and Species. A scientific name consists of two parts, the genus and species names. The scientific name is the most specific classification in scientific nomenclature. In general terms, it identifies a group of organisms that are capable of breeding and producing fertile offspring. The genus name of an organism is always capitalized, while the species name is in lower case. The entire name is either underlined or is in italics. The scientific name may be followed with the name of the taxonomist who first described the species. For example, the scientific name of the Asian tiger mosquito may be written as Aedes albopictus or as *Aedes albopictus*. Aedes albopictus (Skuse) indicates that this species was originally described by a taxonomist named Skuse.

Section II. INSECT MORPHOLOGY

5-4. GENERAL

The arthropods have several characteristics in common: a segmented body with paired, jointed appendages; bilateral symmetry; open circulatory system with dorsal heart; a ventral nerve cord; and exoskeleton. The external skeleton is called the cuticle. The cuticle is composed of two parts, a protein and a polysaccharide called chitin. Chitin is highly resistant to desiccation and to many chemicals. Portions of the cuticle are covered by hardened plates composed of sclerotin that gives the exoskeleton its rigidity, provides muscle attachment, and shields internal organs. We will use insects as the model to describe arthropods. All insects have three distinct body regions; head, thorax, and abdomen (Figure 5-1).

5-5. HEAD

The anterior region of the insect is the head. Its principal appendages are the mouth parts and a single pair of antennae. The head also has a pair of compound eyes and three simple eyes.

a. Mouthparts. The insect mouthparts are composed of a single labrum, a pair of mandibles, two maxillae, and a labium. There are many variations of these, but the three basic types of mouthparts are chewing, sponging, and piercing-sucking. Some insects have one type of mouthparts in their immature stages and another as adults (Figure 5-2).

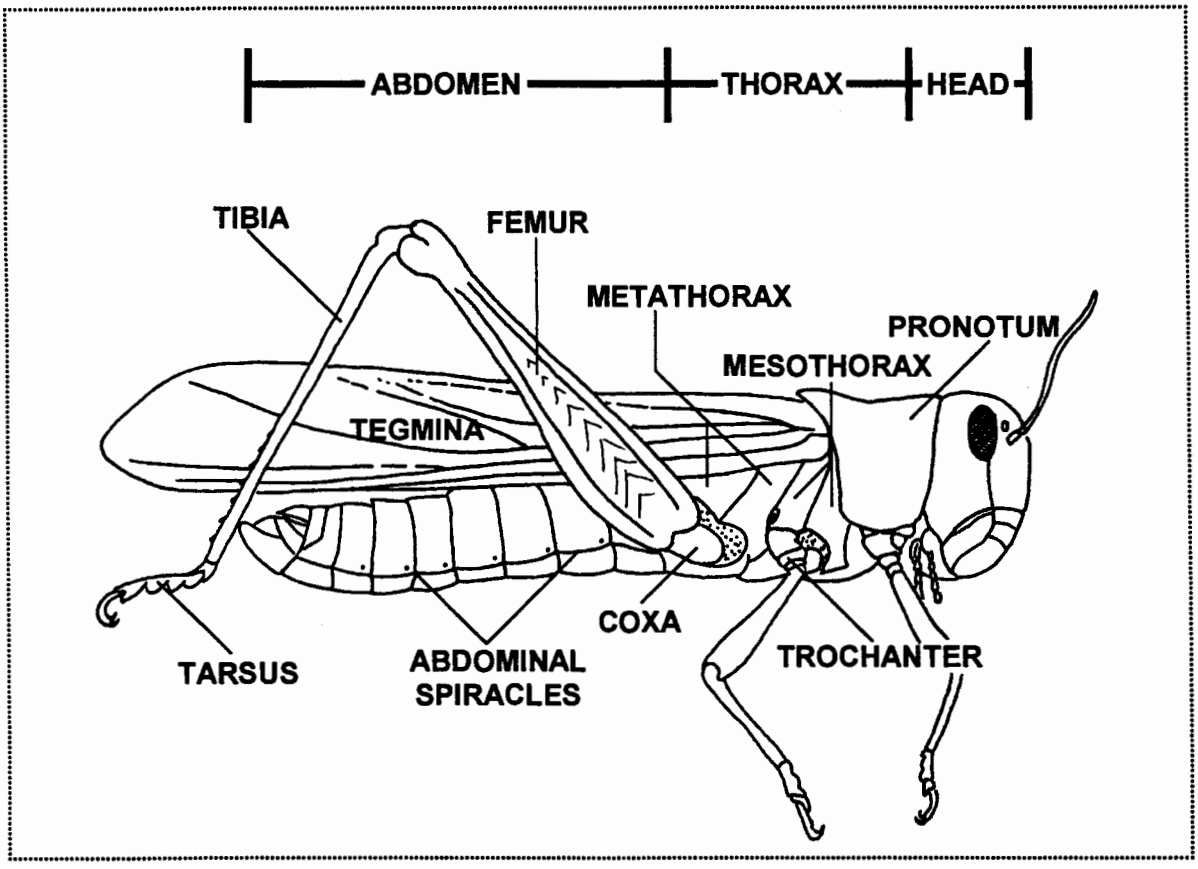


Figure 5-1. Insect body regions.

(1) Chewing mouthparts. Insects that grind solid food have chewing mouthparts. Tooth-like mandibles do the grinding, and the maxillae, labrum, and labium are used to handle food and pull it into the mouth before it is swallowed. Small appendages (called palpi) on the maxillae and labia feel, taste, and smell food. Some insects also have a tongue-like appendage called the hypopharynx inside the mouth.

(2) Sponging mouthparts. Sponging mouthparts are adapted for sucking up liquid or readily soluble foods. The house fly is typical of insects with sponging mouthparts. The labrum and labium join to form a feeding tube called a proboscis. The labium has a swollen, spongy tip called a labellum. To dissolve soluble solid foods, the fly regurgitates a droplet of saliva onto the food. It then pumps the dissolved food solution through the proboscis as a liquid.

(3) Piercing-sucking mouthparts. Other insects use piercing-sucking mouthparts to penetrate the outer covering of a host or prey (plant or animal) and suck out internal fluids. As with the sponging type of mouthparts, the feeding tube is called a proboscis. It lacks an enlarged labellum of sponging mouthparts. Piercing-sucking mouthparts are typical of most blood-feeding arthropods (Figure 5-2).

b. Antennae. Insects have a single pair of antennae on the front of the head. The antennae are sensory organs with tactile and chemical receptors. There are considerable variability in antenna shapes between species and between sexes within species. For this reason, antennae are useful for identification (Figure 5-4).

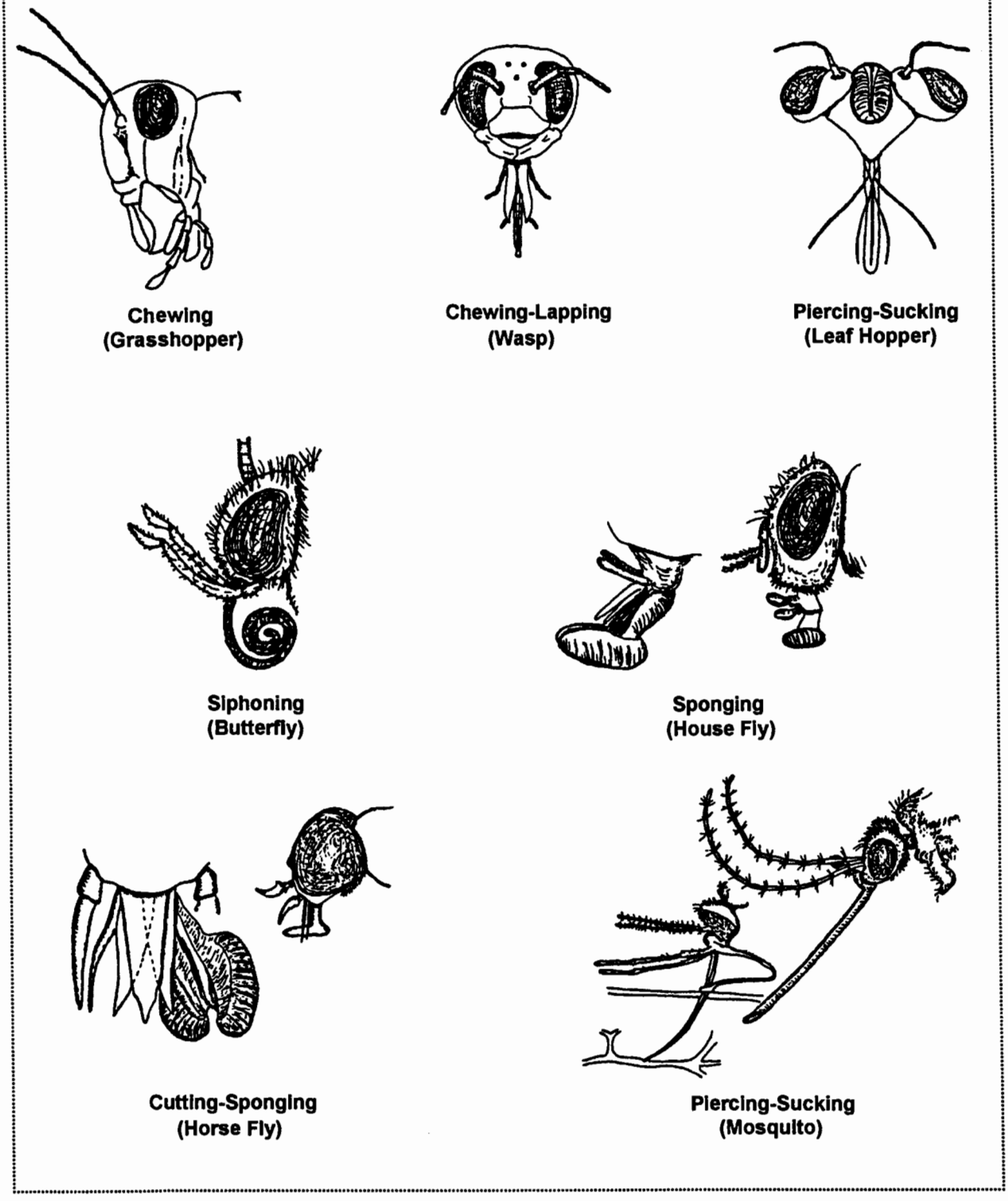


Figure 5-2. Insect mouthparts.

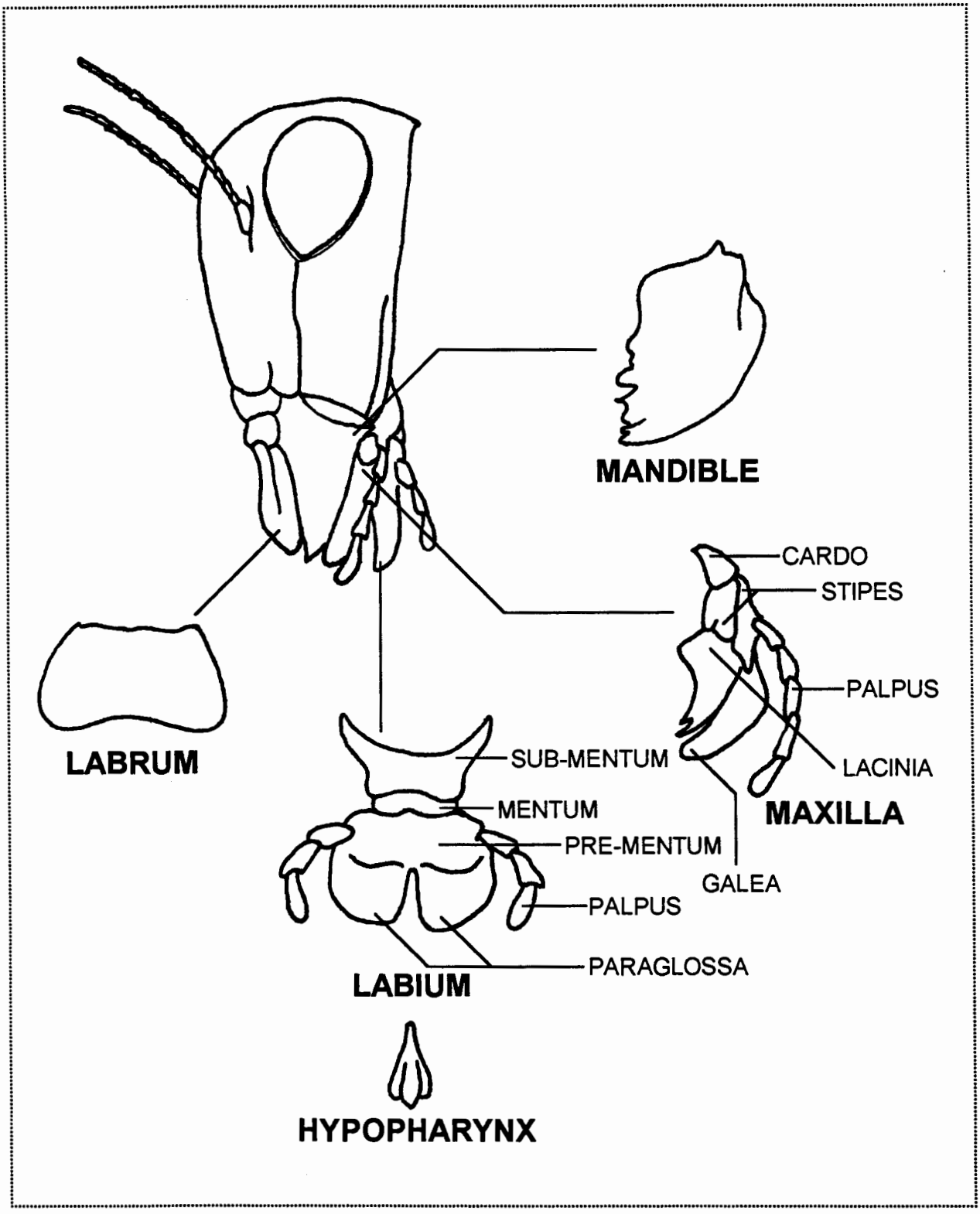


Figure 5-3. Insect chewing mouthparts.

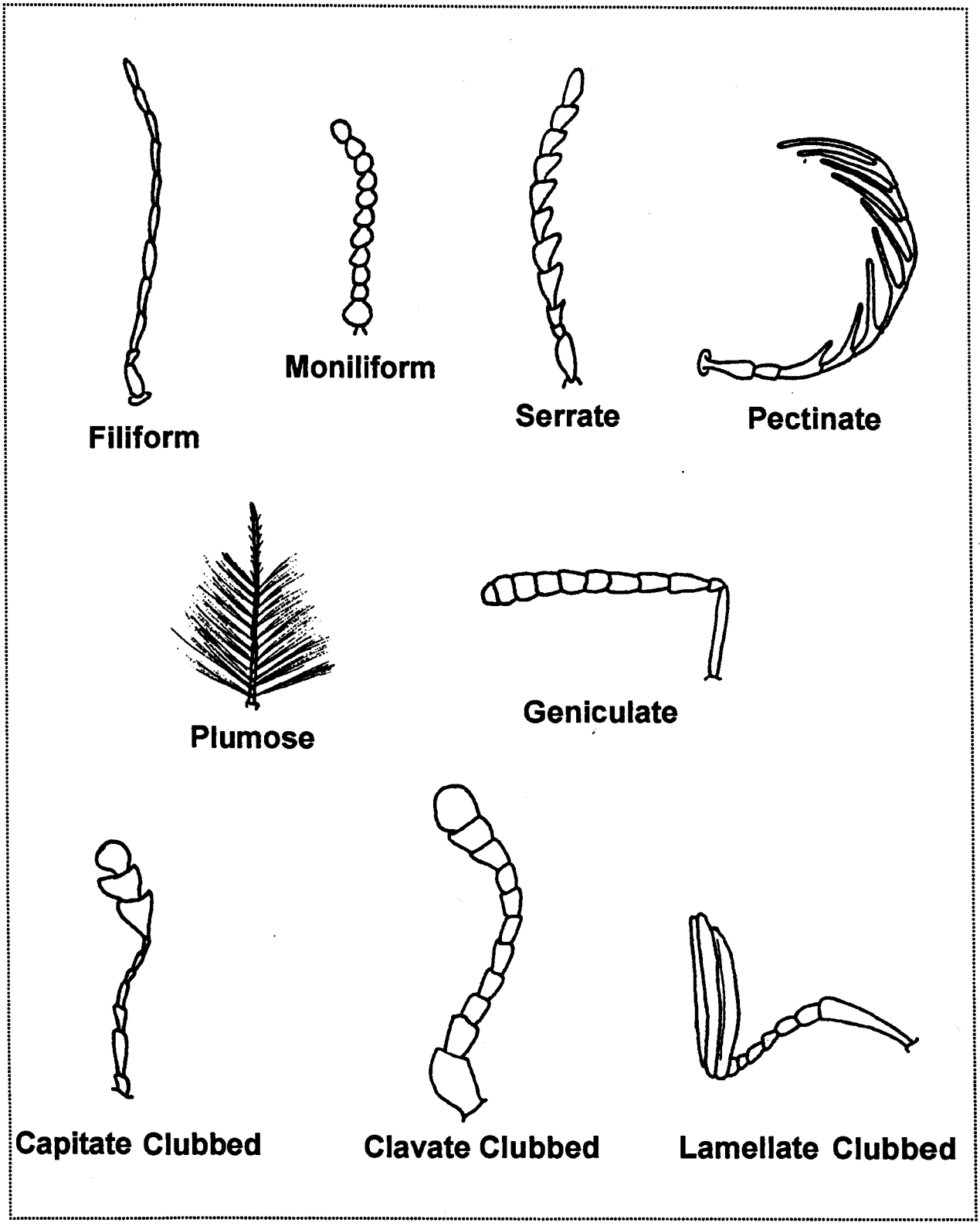


Figure 5-4. Insect antennae.

c. Eyes. Insects have two types of eyes--simple eyes and compound eyes. The three simple eyes or ocelli consist of single eye units or facets. Ocelli are often arranged in the form of a triangle between the large compound eyes. There are also a pair of compound eyes. These are usually round, oval, or kidney-shaped. The outer face of each compound eye is composed of many small, six-sided lenses called facets, each having a fixed focal range. The compound eyes are adept at detecting motion, and the size of these eyes is related to the insect's demands for motion detection.

5-6. THORAX

The insect thorax is the middle body region. The thorax is composed of three fused segments--the anterior prothorax, middle mesothorax, and posterior metathorax. These are, in turn, made up of varying numbers of plates called sclerites. Each thoracic segment has a single pair of legs and may also have a pair of spiracles. Wings, when present, are attached to one or both of the last two thoracic segments.

a. Legs. There is considerable variability in leg structure. Legs may be short and strong for digging (fossorial) or lengthened for jumping (saltatorial) or walking (ambulatory). However, they usually are made up of the same main parts. The leg is divided into a coxa, trochanter, femur, tibia, tarsus, and pretarsus. The femur and tibia correspond to the human femur and tibia, and the tarsus has a function similar to the human foot. Some tarsal segments may bear pads or pulvilli, which help the insect walk on smooth surfaces like glass.

b. Wings. Insects are the only arthropods with wings. Insect wings are membranous extensions of the body wall with an upper and lower layer supported by reinforcing structures called veins. Wing veins that run from the base of the wing to its apex are called longitudinal veins. Cross veins cross the wing transversely and connect the longitudinal veins. The arrangement and number of wing veins are important characteristics for identifying insects. Most insects have two pairs of wings. The wings may act independently in flight as in dragonflies, or they may be fused together as in bees, wasps, and many moths. Some insects like the beetles have forewings that are greatly thickened to protect the softer abdomen. True flies have lost the second pair of wings and are left with small wings known as halteres. A few insects such as silverfish and fleas lack wings completely.

5-7. ABDOMEN

The abdomen, or third body region, has segments or joints, bearing the spiracles and external reproductive organs. Spiracles are external openings for the respiratory system; some insects have a pair on each abdominal segment. The external sex organs used for copulation and egg laying are on the terminal eighth and ninth segments of most insects. The female egg laying organ is called the ovipositor. There are also tail-like appendages called cerci on the terminal segment of some insects such as the silverfish.

5-8. INSECT METAMORPHOSIS

a. Molting. Arthropods have an exoskeleton composed of chitin. The exoskeleton is incapable of growth, though it may have some flexibility. Because of this, insects undergo a series molts in which the old cuticle (exuvia) is shed and replaced by new cuticle. Molting allows for growth and the development of external structures. The molting process is under hormonal control. Synthetic analogs of these hormones can be used in pest management to interfere with normal insect development. The developmental process associated with molting is called metamorphosis. The development of insects may be classified as aemetamorphosis, gradual metamorphosis, incomplete metamorphosis, and complete metamorphosis.

b. Aemetamorphosis. Some primitive insects such as the silverfish and springtails do not undergo any significant morphological changes other than size as they develop to sexual maturity. This type of development is referred to as no metamorphosis or aemetamorphosis.

c. Gradual Metamorphosis (= Hemimetabolous). Other insects undergo proportional changes in certain morphological structures with each molt toward maturity. There are three life stages: egg, immature nymph, and adult (Figure 5-5). Development of wings and other external features also occurs with molts in this type of metamorphosis. The immature stages of these insects are known as nymphs. Common insects that exhibit gradual metamorphosis include the cockroaches, grasshoppers, and true bugs.

d. Incomplete Metamorphosis (= Paurometabolous). Certain insects that are aquatic in their immature stages have a special type of gradual metamorphosis known as incomplete metamorphosis (Figure 5-5). In these insects, external development takes place beneath a protective cuticular case. The immature naiad crawls out of the water prior to the last molt. Dragonflies and damselflies are typical of insects with incomplete metamorphosis.

e. Complete Metamorphosis (= Holometabolous). The most phylogenetically advanced insects undergo complete metamorphosis (Figure 5-5). These insects have four distinct life stages: egg, larva, pupa, and adult. Typically, the larval morphology differs greatly from that of the adult. The mouthparts and diets may be different, and larval habitat often differ from that of the adult. For flying insects, wings occur only on the adults. The transition stage between the larva and the adult is known as the pupa. Insects that have complete metamorphosis include the true flies, beetles, and fleas.

Section III. COMMON ARTHROPOD CLASSES

5-9. GENERAL

There are numerous classes of arthropods, many of which have little significance for human health or well being. However, five that compete for our resources or threaten our health include the Classes Insecta, Arachnida, Diplopoda, Chilopoda, and Crustacea.

5-10. CLASS INSECTA

The Class Insecta has by far the most number of species in the phylum Arthropoda. The insects, as a group, are our chief competitor for our resources, including food, natural fibers and structural products such as wood. Insects also are a tremendous threat to human health by serving as vectors of disease organisms (e.g., mosquitoes-malaria, dengue, encephalites viruses; lice-epidemic typhus; houseflies-bacillic dysentery and other intestinal diseases). Others cause direct injury through venomous stings (e.g., bees, wasps) or toxic secretions (e.g., blister beetles). In addition, insects may become a significant source of annoyance affecting morale when populations become too great.

5-11. CLASS ARACHNIDA

Class Arachnida includes the ticks, mites, spiders, and scorpions. Among the many species of arachnids are some of the most important parasites and vectors of pathogens to man and beast. Others are capable of delivering dangerously venomous bites and stings.

a. Identification. Some arachnids lack distinct body segmentation (ticks, mites, spiders) and others (scorpions, psuedoscorpions) are clearly segmented. The body is divided into two parts: anterior the cephalothorax composed of the fused head and thorax, and the abdomen. Adult arachnids generally have four pairs of legs, though the larvae of ticks and most mites have three pairs. In spiders, there is a pair of pedipalpi, which may resemble an additional pair of legs. All arachnids lack wings and antennae. Eyes, when present, are simple. Mouth parts usually consist of a pair of piercing chelicerae, the pedipalpi, and in ticks and some mites, a hypostome.

b. Life Cycles. All orders of Arachnida deposit eggs except for the scorpions and some mites which bear live young. Eggs are usually numerous, particularly in the ticks. Newly hatched arachnids have the general appearance of the adults, although the number of legs may vary; e.g., tick larvae have three pairs of legs. Metamorphosis is simple.

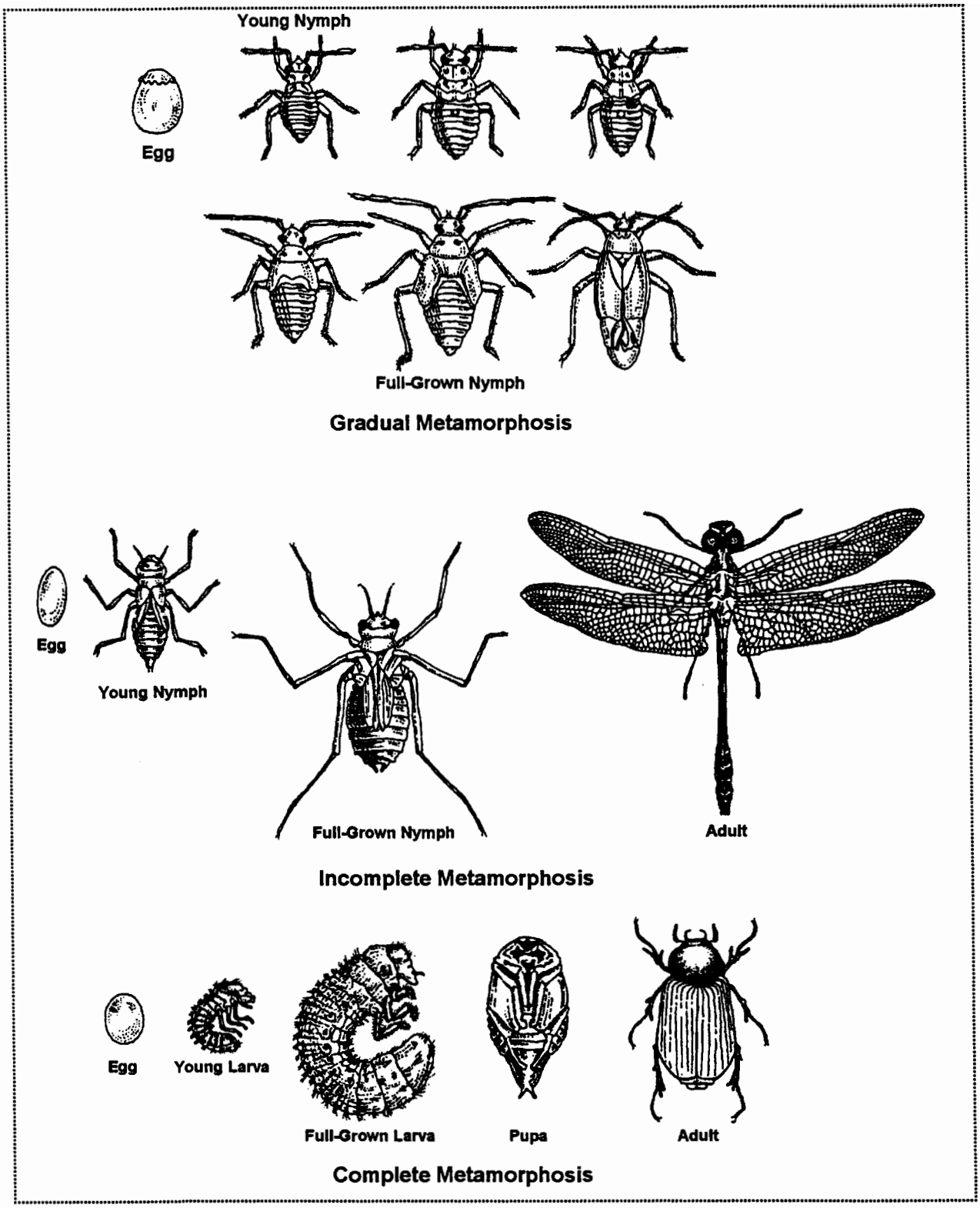


Figure 5-5. Various forms of insect metamorphosis.

c. Scorpion. There are only about 20 scorpions that are capable of causing serious injury or death if they sting man and another 30 that are less dangerous. Nevertheless, most scorpion stings are painful and may be accompanied by a variety of symptoms due to the cardiotoxic and neurotoxic actions of the venoms on various organs. The venom of the scorpion is produced in a pair of glands situated within the telson and is injected into the victim through the stinger at its tip. Antivenoms are available in some countries against the most important local species.

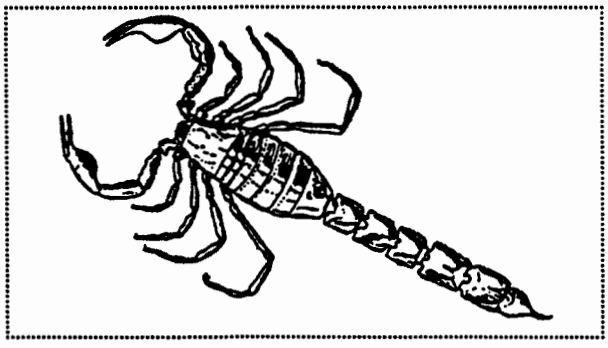


Figure 5-6. Scorpion.

d. Spiders. About 30,000 species of spiders have been described with very few posing any danger to man. Those that do, can harm in one of three ways: mechanical injury through bites; lancing irritant hairs; or injecting venomous bites. Spider venoms differ greatly both in the effect they have on the nervous system and in their ability to digest tissue. Two dangerously venomous spiders in the US are the brown recluse and the black widow.

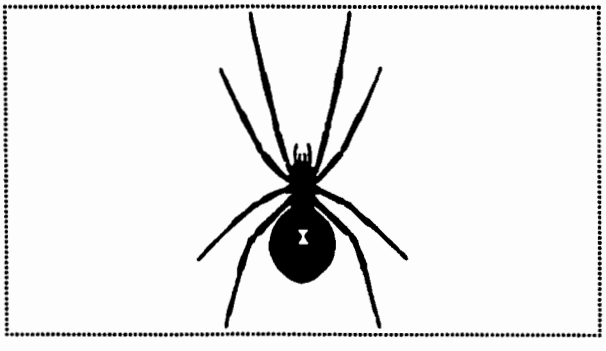


Figure 5-7. Spider.

e. Ticks. Ticks are not venomous, but they are responsible for transmitting numerous diseases (for example, Rocky Mountain spotted fever, Lyme disease, tularemia, scrub typhus, etc.). Ticks are usually found in vegetated areas where they quest for a host. Once they have acquired a host, they will seek out a place to attach and take a blood meal. It is during the time of attachment that transmission occurs. Some tick-born diseases cause acute illness like Rocky Mountain spotted fever. Other tick-borne diseases may cause chronic symptoms.

Figure 5-8 Ticks.

5-12. CLASS CHILOPODA

Centipedes are wormlike in form, with a distinct head that possess a pair of antennae, and with many fairly similar body segments, each with one pair of segmented appendages. Most centipedes are predaceous, feeding mainly on insects. They are provided with powerful poison claws, the maxillipeds, located immediately ventral to the mouth and connected by means of a hollow tube to large poison glands. The large centipedes are commonly regarded as venomous and are generally much feared.

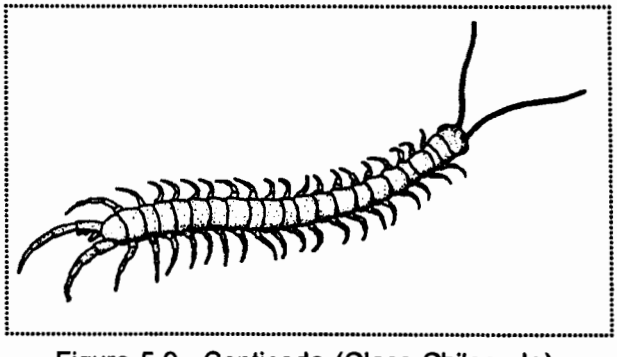


Figure 5-9. Centipede (Class Chilopoda).

5-13. CLASS DIPLOPODA

Millipedes differ from centipedes in that most apparent body segments possess two pairs of appendages instead of one. Millipedes are vegetarians and lack poison fangs characteristic of centipedes. In most species the body is cylindrical, and the numerous legs, as well as the antennae, are relatively short and inconspicuous. Certain species of millipedes serve as intermediate hosts for different species of parasites of humans and other mammals. Others produce noxious defensive chemicals that can injure eyes and cause digestive disturbances, if ingested.

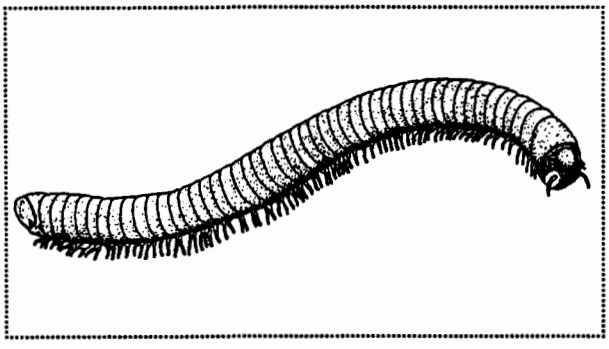


Figure 5-10. Millipede (Class Diplopoda).

5-14. CLASS CRUSTACEA

The Crustacea are a very diverse group of mostly marine arthropods. The crustaceans exhibit considerable morphological variation. Typically, there are two pairs of antennae, more than four segments and four or more pairs of legs. There may be two distinct body regions, the cephalothorax and the abdomen, or there may be little differentiation between body regions. The cephalothorax is covered by a shield-like carapace in many species. The crustaceans generally present little or no economic or health threat to humans.

- A few aquatic species serve as intermediate hosts for human parasites, and the terrestrial sow bug or "rolly polly" can sometimes be a minor pest in gardens and greenhouses.
- Some aquatic and marine crustaceans such as crawfish, lobsters, and crabs are valued as a food source.

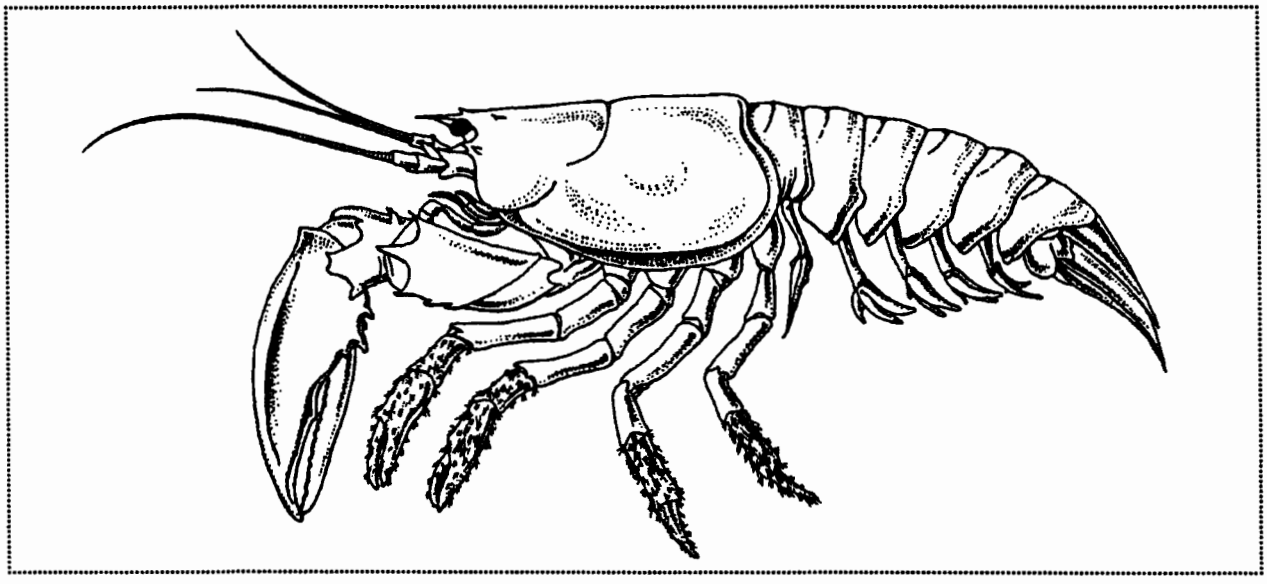


Figure 5-11. Crawfish (Class crustacea).

COMMON ARTHROPOD CLASSES

Class	Example
☼ **Insecta**	mosquitoes
	lice
	hoseflies
☼ **Arachnida**	ticks
	mites
	spiders
	scorpions
☼ **Chilopoda**	centipedes
☼ **Diplopoda**	millipedes
☼ **Crustacea**	crawfish
	lobsters
	crabs
	shrimp

5-15. CLOSING REMARKS

This brief discussion provides a very basic overview of the arthropods. It is hardly a comprehensive coverage of the group. We did not discuss the internal morphology. Nor did we discuss physiological processes such as reproduction, respiration, and digestion, all of which are important in understanding and developing control strategies for this very large and diverse group of organisms.

EXERCISES, LESSON 5

REQUIREMENT. The following exercises are to be answered by selecting the correct letter, completing the incomplete statement, or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. In the scientific name *Aedes aegypti* the genus is _____ and the species is _____.

2. The hardened plates of the arthropod exoskeleton:

   a. Provide _____.

   b. Provide _____.

   c. Provide _____.

3. Chitin protects arthropods from _____ and _____.

4. Insect mouthparts are made up of the labrum, two _____, two maxillae, the labium, and sometimes a tongue-like hypopharynx.

5. Which of the following mouth parts are adapted for grinding solid foods?

   a. Chewing mouth parts.
   b. Sponging mouth parts.
   c. Piercing-sucking mouth parts.

6. The swollen distal end of the labium of sponging mouth parts is called the _____.

7. Wings, when they are present, are attached to one or both of the last two thoracic segments.

a. TRUE.
b. FALSE.

8. Insects with _____ or _____ simply get larger with each molt, exhibiting little or no morphological changes.

9. The four developmental stages of insects with complete metamorphosis are the:

a. _____

b. _____

c. _____

d. _____

10. Some arachnids such as ticks and mites have fused segments forming one general body region.

a. TRUE.
b. FALSE.

11. The Class Diplopoda have _____ pair(s) of appendages per body segment.

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 6	Animal Damage Control.
LESSON ASSIGNMENT	Paragraphs 6-1 through 6-11.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to employ integrated pest management strategies to control vertebrate animals causing damage IAW Timm, *Prevention and Control of Wildlife Damage* and Schemnitz, ed, *Wildlife Management Techniques Manual.*
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 6-1. Identify vertebrate animals commonly responsible for damage to Army real property. 6-2. Identify appropriate techniques for controlling an animal damage situation.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 6

ANIMAL DAMAGE CONTROL

Section I. INTRODUCTION

6-1. INTRODUCTION

Animal damage control is one of the many tools of resource management. Like all the others, it is a means to accomplish an objective and never an end. Animals cause thousands of dollars of damage to government and private property every year.

a. Need for Control. Wildlife damage is primarily associated with feeding activity, and to a lesser extent, associated with denning, nesting, or roosting behavior. Basically, the animals involved may just be in the "wrong place" at the "right time." Every conflict does not necessarily call for corrective action, but it is the sustained damage, "the total picture," that demands the manager's attention. Animal damage control is complex. There is no "cookbook" guide or barometer to tell when control is needed. Each situation must be weighed individually on its own merits and in relation to other ecological and health considerations.

b. Public Opposition. Opposition from animal welfare/rights groups has had a major impact on animal control practices. In many instances, pest managers have stopped animal control activities rather than deal with intimidating and aggressive animal welfare/rights groups. Unfortunately, the animals in these areas often become overpopulated and cause tremendous damage to property. In some areas, there have been outbreaks of zoonotic diseases in animals. Some of these diseases have spread to the human population; deaths have occurred. The community must then react to the situation, and the animal populations are often decimated.

The objective of animal control is not to decimate animal populations, but to maintain a sustainable population for the benefit of the animals as well as the human population.

6-2. DAMAGE ASSESSMENT

While assessment of damage and the determination of the responsible species may be rather simple for one with experience, the untrained observer may have a difficult time. In examining the damage, one must look for "clues." Obviously, the best clue is actually observing the species doing the damage, but the investigator may not have this opportunity. Therefore, "signs" such as tracks, tooth marks, droppings, dens, burrows, and trails must be sought. Together with these "signs," familiarity with the habits of wildlife will aid in the determination of the species. Identifying the species may be difficult at times, since similar types of damage can be caused by more than one animal.

Section II. VERTEBRATE ANIMALS RESPONSIBLE FOR PROPERTY DAMAGE AND CONTROL TECHNIQUES

6-3. RODENTS AND SMALL MAMMALS

a. Beavers.

(1) Damage. The presence of beaver damage is readily evident by noting the coneshaped stumps of trees and freshly peeled sticks scattered around the areas and floating in the water. If large ponds, lakes, or streams are being utilized by a beaver colony, a dam may not be present. However, generally, a bank den or lodge will usually be in the vicinity. The major damage caused by beavers is not just the timber they cut, but more importantly, the timber, pastures, croplands, and roads flooded by their dam building activities.

(2) Control Techniques. Habitat modification, live trapping, conibear traps, and leg hold traps are control techniques.

b. Marmots (Ground Hogs and Woodchucks).

(1) Damage. Earthen mounds near marmot burrows may cause damage. The burrows may damage equipment. When dug along water conveying ditches, the burrows also may cause a loss of irrigation water. Marmots can sharply reduce forage production by their feeding activity. Additional evidence of the presence of marmots includes droppings, burrows, and trails leading to and from the damaged area to dens or loafing areas. During spring, occupied woodchuck burrows are easily recognizable by the presence at the burrows entrance of dirt pellets, ranging from marble to fist size.

(2) Control Techniques. Fumigants, conibear traps, leg hold traps, and strychnine-treated bait are used.

c. Rabbits and Hares.

(1) Damage. Rabbits and hares may damage or completely destroy a wide variety of tree plantings, gardens, ornamentals, agricultural crops, and rehabilitated rangeland. They can also strip bark from established fruit trees and conifers. Quite often, rabbits or hares may be observed doing damage. Other evidence of their presence are tracks and trails leading to and from the damaged area.

(2) Control techniques. Habitat modification, fencing and proofing, repellents, live traps, body snares, and toxic baits (anticoagulants and strychnine) can be used.

6-4. CARNIVORES AND OTHER PREDATORS

a. Coyotes, Wolves, and Dogs.

(1) Damage. These three canids prey on a wide variety of animals, ranging from big game and livestock to rodents, wild birds, and poultry. Complaints of pets being killed,

particularly by coyotes, have also increased with urbanization. Wolves prey on the larger ungulates such as caribou, moose, and elk. Dogs can be a serious problem to livestock. Coyotes can also cause extensive livestock losses.

(2) Control Techniques. Control by fencing, den hunting, snares, and leg hold traps.

b. Opossum.

(1) Damage. Opossums are omnivorous creatures, eating fish, crustaceans, insects, mushrooms, berries and other fruits, vegetables, eggs, and carrion. They are well know for predation on birds and eggs. They are known to scavenge through garbage when given the opportunity.

(2) Control Techniques. Control can be accomplished by live traps, leg hold traps, and exclusion fencing.

c. Raccoons.

(1) Damage. Raccoons are omnivorous; availability seems to govem raccoon diet. Most often, raccoons eat whatever they encounter such as mice, small birds, snakes, frogs, insects, crawfish, grass, berries, acorns, corn, melons--the list is almost endless. During lean periods when living in urban areas, they will raid garbage cans and dumps; these may be a major source of food in urban areas. Raccoons are an important reservoir of rabies in the Eastem United States.

(2) Control Techniques. Live traps, leg hold traps, and exclusion fencing can be used.

d. Skunks.

(1) Damage. Skunks consume a large number of insects, and their fondness for these may result in depredations on beehives. They usually dig small cone-shaped holes in lawns, golf courses, and meadows in search of beetle larvae and grubs. A less serious but common complaint of objectionable odor occurs when one or more skunks take up residence under buildings used by humans. Skunks are another important reservoir for rabies, especially in the Central United States.

(2) Control techniques. Live traps are successful.

e. Feral Cats.

(1) Damage. Feral cats feed extensively on small songbirds, game birds, mice and other small rodents, rabbits, and other valuable wildlife. Feral house cats serve as an important reservoir for human and wildlife diseases like ringworm, toxoplasmosis, leptospirosis, distemper, and rabies.

(2) Control techniques. Use live trapping.

6-5. UNGULATES

a. Deer, Elk and Moose.

(1) Damage. Overpopulation of deer and elk can have adverse effects on forest regeneration and maintenance of habitat for other wildlife. They may compete with livestock on rangelands, causing crop and orchard damage. In addition to the immediate loss of the damaged crop, there is often residual damage in the form of yield reduction of fruit trees or forage crops. Deer are an important host for the ticks *Ixodes scapularus* and *Tr. pacificus*, the primary vectors of Lyme disease in the United States.

(2) Control techniques. Habitat modification, fencing and barriers, repellents, hunting, and trapping are control techniques.

6-6. BIRDS

a. General Information. Birds are generally thought of as beneficial and pleasant to have around. When they congregate in large numbers, they can become a significant nuisance with their noise, feces, and feeding habits. Birds are particularly hazardous when they congregate near airports. Bird strikes have caused aircraft crashes and loss of human life. Birds cause thousands of dollars of damage every year.

b. Pigeons.

(1) Damage. Excessive pigeon populations can cause property deterioration and can constitute a health hazard. Pigeons are associated with the transmission of ornithosis, encephalitides, cryptococcoses, toxoplasmosis, histoplasmosis, salmonellosis, and coccidiosis. There are many incidents where food stored in large warehouses has been condemned because of pigeon droppings.

(2) Control techniques. Mechanical frightening devices, toxic bait, toxic perches, traps, proofing and screening, and chemical frightening agents are used.

c. Waterfowl (Ducks, Geese, and Sandhill Cranes).

(1) Damage. Damage generally involves crops within a few miles of or within waterfowl roosts. Within this general area, birds will fan out and feed in selected sites. During the summer molting period, waterfowl are flightless and damage occurs within walking distance of their roosts. Once waterfowl have established a feeding pattern, they become increasingly difficult to move. Damage generally occurs during daylight, especially during morning and evening hours.

(2) Control techniques. Mechanical frightening devices, lure crops, and feed stations can be used.

d. Swallows and House Sparrows.

(1) Damage. Swallows and house sparrows cause problems when they roost in garages, aircraft hangers and warehouses. These birds build their nests in open eaves of houses, and in rain spouts, causing them to plug.

2) Control technique. Trapping, toxic bait, chemical frightening agents, repellents, habitat manipulation, proofing and screening, and toxic perches have been successful.

e. Sea Gulls.

(1) Damage. Gulls have adapted to existing in close proximity to man and have taken advantage of municipal landfills, fishing ports, and sewage outfalls. This has resulted in an increase of gull populations which concentrate around metropolitan centers and cause problems. A wide range of complaints levied against gulls, include hazards to public safety at airports, depredation to fish at hatcheries, losses of duck eggs and ducklings, contamination of public water supplies, and defacing of property.

(2) Control techniques. Use habitat manipulation, proofing and screening, mechanical and chemical frightening agents.

f. Migratory Bird Treaty Act. Under the Migratory Bird Treaty Act (MBTA), the courts have upheld convictions for bird deaths resulting from application of pesticides to fields and bird deaths resulting from exposure to a pesticide in a wastewater treatment pond. Thus, business activities that may have an incidental and unintentional side effect of killing migratory birds are in potential violations of the MBTA, even though all label directions where adhered to.

6-7. OTHER SPECIES

a. Bats.

(1) Damage. Bats feed almost exclusively on night-flying insects; therefore, their feeding habits are beneficial. However, when they select a building for roosting, they often become a nuisance. Many bats have a characteristic pungent and offensive odor that develops from their droppings and urine. Another source of complaint is the scratchy, scrambling noise, they make while entering and leaving their roosting places. A number of bats are protected as endangered species. Control of bats classified as endangered can only be undertaken if they demonstrate a threat to human safety.

(2) Control techniques. Bat-proofing is the most effective method of eliminating roosting bats from a building. Smaller species of bats can crawl through an opening as narrow as 9.5 mm; therefore, when bat-proofing a building, inspect very carefully to be sure all possible entrances are closed. All bats should be out of the building before bat-proofing is completed.

b. Snakes.

(1) Damage. Snakes are generally beneficial because of the rodents and other pests they eat, but this seldom makes them welcome in areas where they come in contact with people. In the spring and fall many people are confronted with snakes in yards, houses, or other buildings that are not tightly constructed. Poisonous snakes are a danger to humans and domestic animals, but should be controlled only when necessary. At times, nonpoisonous snakes may be undesirable and require control.

(2) Control techniques. The best method of keeping poisonous snakes away from an areas is by using a snake-proof fence. If a snake has entered a house and hidden, one way to lure it out is to put wet cloths on the floor near the area where you think the snake is, and cover them with dry cloths or burlap. Snakes like moisture and shelter and often will crawl between the wet cloths. They can then be removed. If this method does not work, fumigation may be the only alternative.

6-8. THE LAW

Many wild animals are protected by Federal, state, and/or local laws. Consult the installation wildlife specialist or government wildlife specialist before undertaking any lethal control strategy for wild animals. The US Department of Agriculture Wild Animals Damage Control office can also provide assistance in removing wild animals from the installation.

Section III. PUBLIC RELATIONS

6-9. PLANNING ANIMAL CONTROL

a. Importance of Public Relations. People management should not be looked upon as someone else's job, but instead should be considered a positive force that can play an important role in animal control plans. Indeed, a lack of good public relations often can virtually scuttle the best laid plans of the pest control professional. Conversely, public support and understanding can save time, money, and effort in accomplishing management goals.

b. Involve the Public Early. Consideration of the public should take place during the planning stages of any animal control project.

- As soon as the pest management plans have been formulated, the pest management professional should do a bit of reflecting and try to put himself outside the control project.
- You should try to look at the project from the viewpoint of many people.

6-10. PUBLIC EDUCATION

a. Define the Threat. Defuse public fears by disseminating information about animal threats.

- Stress the beneficial nature of the animal species as well as the true extent of the threat.
- This technique works well with species that are widely feared, but for the most part are harmless, yet beneficial (snakes and bats).

b. Involve the Public. Explain why an animal problem occurs and what the housing or building resident can do to help control or eliminate the problem.

- This can range from better sanitation practices, from closing dumpster doors tightly to new trash cans.
- You may be able to remove an offending animal from an area, but unless poor sanitation practices are corrected, another animal will move into the area in a relatively short time.

6-11. PUBLIC RELATIONS.

Be straight forward with animal control efforts.

- Inform. Inform the Public Affairs Office of any animal control efforts or confrontations with animal activists. PAO will be able to help you in informing the public about animal control problems on the installation, what is being done, any disease threat, and what installation personnel can do.
- Contacts. Contact the installation veterinarians and local public health office for handling and trapping requirements when trapping animals. Each area may have different rules on trap and release.
- Interviews. If someone wants to interview you about your animal control program, you MUST contact Public Affairs Office and have the interview cleared by that office.

EXERCISES, LESSON 6

REQUIREMENT. The following exercises are to be answered by selecting the correct letter, completing the incomplete statement, or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List five vertebrates commonly responsible for property damage.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. The vertebrate that damages timber, pastures, croplands, and roads flooded by their dam building activities is _____.

3. List three canids that prey on livestock, wild birds, and poultry.

   a. _____

   b. _____

   c. _____

4. Skunks are an important reservoir for _____, especially in the Central United States.

5. Excessive pigeon populations can cause _____ and _____.

6. List four diseases that may be transmitted by pigeons.

a. _____

b. _____

c. _____

d. _____

7. _____ are generally beneficial because of the rodents and other pests they eat.

8. List four techniques to control damage caused by beavers, ground hogs, and woodchucks.

a. _____

b. _____

c. _____

d. _____

9. List four techniques which can be used to control damage caused by coyotes, wolves, and dogs.

a. _____

b. _____

c. _____

d. _____

10. Techniques used to discourage pigeons from congregating in an area include these three:

a. _____

b. _____

c. _____

11. Under the _____ Act, the courts have upheld convictions for bird deaths resulting from application of pesticides to fields and wastewater treatment ponds.

12. There is a problem with snakes and bats on the military installation. How can public fears be diffused? _____

_____

_____

_____

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 7	Evaluation of Pest Control Operations.
LESSON ASSIGNMENT	Paragraphs 7-1 through 7-4.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to assess pest control operations IAW AEHA (CHPPM) TG 102, TIM 18, AR 40-5, AR 420-76, and AR 420-74.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to:
	7-1. List five elements in the process of evaluating pest control operations IAW AEHA TG 102.
	7-2. Identify the standard evaluation control procedures used to evaluate pest control operations.
	7-3. Identify cooperative sources of program review used to evaluate pest control operations.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 7

EVALUATION OF PEST CONTROL OPERATIONS

7-1. INTRODUCTION

Environmental compliance has become an important issue in recent years. Installation commanders need a comprehensive system to help achieve, maintain, and monitor compliance with the ever-growing body of environmental laws and regulations.

7-2. FIVE ELEMENTS IN EVALUATING PEST CONTROL OPERATIONS

a. Surveillance of Pest Populations. Pest surveillance is an essential aspect of any health and environment program. Surveillance activities enhance the planning, operation, and evaluation of arthropod and rodent pest management programs, whether the programs are designed to control disease agents borne by these pests, or to reduce pest populations to lessen the hazard or discomfort for personnel and real property. The surveillance

ELEMENTS IN THE EVALUATION PROCESS

- Surveillance of a pest population.
- Evaluation of survey results.
- Selection of measures to manage the pest.
- Pest management (control) measures.
- Reevaluation.

program must be documented and on file. Standing operating procedures should be updated annually.

b. Evaluation of Survey Results. From the environmental standpoint, pesticide use and other pest management practices should not be initiated without first substantiating the need for them. This minimizes adverse environmental effects. It is essential to collect and record pest surveillance data to verify the need for control measures prior to the initiation of control measures. This data supports routine preventive pest control programs for recurring pests. Records of surveillance activities and survey results help ensure continuity of the pest management program. Records must be maintained for permanent documentation.

c. Selection of Measures to Manage the Pest. Based on the evaluation of surveillance results, the pest controller will determine the most appropriate pest management strategy. Each situation may have slight variations (e.g., housing units, medical facility, food service facility) that will need to be taken into account when determining the best course of action in dealing with a particular pest problem.

d. Pest Management (Control) Measures. The installation pest management plans should incorporate all aspects of integrated pest management into the control measures. No one method of control is the ultimate control, and many problems can be approached with a combination of measures. When pesticides are used, they must be applied in accordance with state and Federal laws, regulations, and installation policies.

e. Reevaluation. Recurring pest control problems need to be reevaluated to determine the effectiveness of the control measures taken. Upon review, another approach may be warranted.

7-3. STANDARD PROCEDURE FOR EVALUATING CONTROL OPERATIONS

a. Pretreatment Surveillance. Pretreatment surveillance needs to be performed prior to implementing any type of control. This is to determine that there is a pest problem, the pretreatment level of pest infestation, and an appropriate control measure.

b. Post-treatment Surveillance. Post-treatment surveillance should be done on all pest control operations. It documents the efficacy of the treatment and alerts you to a continuing problem that may need reevaluation and development of a different control strategy.

c. Pest Management Records. Pest management records provide the historical data for each pest control site and provide information for workload forecasting. These records are also valuable if there is a complaint of pesticide misuse resulting in illness or environmental damage. It is the responsibility of the pest controller to maintain complete and accurate records of all pest control activities to include pesticide application and surveillance.

7-4. EXTERNAL EVALUATIONS

a. Preventive Medicine Services. Preventive Medicine Services is responsible for the surveillance of medically important pests on installations IAW AR 40-5. Each installation may not have an organic PVNTMED SVC, but the surveillance of medically important pests will fall under the responsibility of the nearest MEDDAC/MEDCEN PVNTMED SVC. The relationship between preventive medicine and the pest control program should be a close working alliance. Preventive medicine can provide valuable pre- and post-treatment surveillance assistance.

b. Center for Health Promotion and Preventive Medicine (CHPPM). CHPPM provides many valuable resources for installation pest management programs. There are entomologists located within CHPPM that are able to provide assistance and/or recommendations on the handling of various pest control problems. The Pesticide Hotline provides information on pest management issues via electronic mail and by phone. It also provides information on pesticides.

c. Pest Management Program Review. A pest management program review can also be requested by contacting the MACOM

entomologist. A program review looks at the complete pest management program and follows the format found in TIM 18. This is an internal Army review that allows an installation to identify discrepancies and deficiencies, providing advice on how to fix them prior to an environmental compliance assessment survey.

d. Environmental Compliance Assessment Survey. To address the increasingly complex issues of environmental compliance, Headquarters, Department of the Army established the Environmental Compliance Assessment System.

- This program, developed by the US Army Corps of Engineers under the direction of Headquarters, Department of the Army, provides installation commanders a proactive approach to environmental compliance.
- Work on environmental compliance assessment surveys began in 1987, with full implementation beginning in 1992.
- The main purpose of these surveys is to help commanders identify the resource requirements necessary to ensure that their installations are in full compliance with all Federal, state, local, Department of Defense, and Army environmental regulations.

EXERCISES, LESSON 7

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List five elements in the process of evaluating pest control operations.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. Three standard evaluation control procedures used to evaluate pest control operations are:

   a. _____

   b. _____

   c. _____

3. In the area of surveillance, Preventive Medicine Services is responsible for

_____

_____

_____

_____

4. Contact the Center for Health Promotion and Preventive Medicine hotline for information on _____ and _____.

5. For an internal Army review of the installation pest management program prior to an Environmental Compliance Assessment Survey, contact _____.

6. A part of standard procedure for evaluating pest control operations is pretreatment surveillance. List three reasons to perform this surveillance before implementing any type of pest control.

a. _____

_____

b. _____

_____

c. _____

_____

7. What is the value of post-treatment surveillance? _____

_____

_____

8. List two values of pest management records.

a. _____

_____

_____

b. _____

_____

_____

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 8	Pesticides and the Environment.
LESSON ASSIGNMENT	Paragraphs 8-1 through 8-21.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to employ knowledge of pollution and ecology to decrease environmental hazards associated with pesticide use IAW AR 420-76 and AR 200-1.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 8-1. Identify the factors affecting the fate of pesticides in the environment. 8-2. Identify the procedures used to minimize groundwater contamination by pesticides. 8-3. Identify application methods and formulations to reduce injury to nontarget organisms.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 8

PESTICIDES AND THE ENVIRONMENT

Section I. PESTICIDE TRANSFER AND BREAKDOWN PROCESSES

8-1. INTRODUCTION

a. The State of Our Environment. As our population continues to grow, so do our demands for clean water and air, and an environment that is not threatening to our health and safety. We have become increasingly concerned about the state of our environment. We worry that the earth's natural resources are not only being depleted, but also becoming polluted and unfit for human use. As a result, many of the activities that we have taken for granted are now being carefully examined for potential damage to the environment. Pesticides are but one group of chemicals being blamed for environmental abuse.

b. Information in This Lesson. This lesson explores the fate of pesticides after application. You will learn about groundwater and how it can become contaminated. We will also discuss the effects of pesticides on nontarget organisms and the environment. For our purposes, environment means all of our physical, chemical, and biological surroundings, such as climate, soil, water, air, and all species of plants, animals, and microorganisms.

8-2. PESTICIDE FATE

As soon as pesticide is released into the environment, a pesticide is affected by various processes.

a. Beneficial Processes. Sometimes these processes are beneficial and enhance pest management. For example, the leaching of a root-absorbed herbicide into the root zone can enhance weed management. The degradation of pesticides can remove nonessential pesticide residues from the environment.

b. Detrimental Processes. However, these processes can be detrimental. Runoff can move a pesticide away from target pests. As a result, chemical is wasted, control is reduced, and there is an increased chance of damage to nontarget plants, hazard to human health, and pollution of nearby soil and water.

c. The Processes. In this lesson, the processes examined are adsorption, absorption, volatilization, runoff, leaching, crop removal, microbial degradation, chemical degradation, and photodegradation.

8-3. ADSORPTION

a. Definition. Adsorption is the binding of chemicals to soil particles. The amount and persistence of pesticide adsorption varies with pesticide properties, soil moisture content, soil acidity, and soil texture. Soils high in organic matter or clay are the most adsorptive. Coarse, sandy soils that lack organic matter or clay are much less adsorptive.

☼ ADSORPTION

The binding of chemicals to soil particles.

b. Application Effects. A soil-adsorbed pesticide is less likely to volatilize, leach, or be degraded by microorganisms. When pesticides are tightly held by soil particles, they are less available for absorption by plants. For this reason, certain pesticides used on highly adsorptive soils often require higher rates or more frequent applications to compensate for the pesticide which binds to the soil particles.

8-4. ABSORPTION

Absorption is the process by which chemicals are taken up by plants and microorganisms. It is a process that can transfer pesticides in the environment. Once absorbed, most pesticides are degraded within plants. However, residues may persist inside the plant or be released back into the environment as the plant tissues decay.

☼ ABSORPTION

The process by which chemicals are taken up by plants and microorganisms.

8-5. DRIFT

a. Definition. Drift is the movement of pesticides away from the target site on the wind. Drift can occur with both liquid and solid formulations. Small droplets and dusts are particularly susceptible to drift. Environmental conditions that enhance drift include strong wind and high temperatures which can cause convective lifting of pesticides.

☼ DRIFT

The movement of pesticides by the wind away from the target site.

b. Application Effects. Strong winds may carry pesticides hundreds of meters or even miles from target sites. This can result in less than desired application rates on the target site and cause environmental damage in the form of wildlife and fish kills, damage to desirable plants, or damage to people exposed to pesticides long distances from the site of application. Aerial pesticide applications are particularly vulnerable to drift because of the altitude at which they are applied.

c. Reduction of Drift. Avoid applying liquid pesticides and dusts during windy conditions. Use the lowest recommended pressure and largest recommended spray nozzles when applying liquids. Adjust spray booms so that they are as close to the ground as practical, and use boom shrouds when possible. Make aerial pesticide applications only when weather conditions are favorable (i.e., temperature<85°F; wind<10 mph; ground temperature < air temperature).

8-6. VOLATILIZATION

a. Definition. Volatilization occurs when a solid or liquid turns into a gas. Volatilization of pesticides increases with higher air temperature and air movement, higher temperature at the treated surface (soil, plant, etc.), and low relative humidity. Small spray droplets enhance volatilization. Pesticides also volatilize more readily from coarse-textured soils and from medium to fine texture soils with high moisture content.

☼ VOLATILIZATION

The formation of a solid or liquid into a gas.

b. Application Effects. A pesticide in a gaseous state can be carried away from a treated area by air current; the movement of pesticide vapors in the atmosphere is called vapor drift. Unlike the drift of sprays and dusts that can sometimes be seen during an application, vapor drift is invisible.

c. Reduction of Volatilization. Avoid applying volatile pesticides when conditions favor volatilization. The vapor pressure rating of the pesticide may help indicate the volatility of the material. The higher the vapor pressure, the more volatile the pesticide. Volatilization can be reduced through the use of formulations with low volatility and incorporation of the pesticide with a non-volatile carrier.

8-7. RUNOFF

a. Definition. Runoff is a process that moves pesticides in water. Runoff occurs as water moves over a sloping surface. Runoff carries pesticides either mixed in the water or bound to eroding soil. The amount of pesticide runoff depends on:

- The grade or slope of an area.
- The erodibility and texture of the soil.
- The soil moisture content.
- The amount and timing of irrigation or rainfall.
- The properties of the pesticide.

For example, a pesticide application made to a heavy clay soil already saturated with water is highly susceptible to runoff. Established vegetation or plant residues reduce runoff because of their ability to retain soil and moisture.

☼ RUNOFF

The process on the surface of soil that moves pesticides in water.

b. Reduction of Runoff. Pesticide losses from runoff are greater when heavy rainfall occurs shortly after a pesticide application. If heavy rainfall is expected, delay applying pesticides. Studies have shown that some no-tillage and minimum-tillage cropping systems can reduce pesticide runoff, as do soil incorporation application methods. In addition, adjuvants that promote pesticide retention on treated surfaces can reduce pesticide content in runoff water. Finally, surface grading, drainage ditches, dikes, and the use of border vegetation can help reduce the amount and control the movement of runoff waters.

8-8. LEACHING

a. Definition. Leaching is another process that moves pesticides in water. In contrast to runoff which occurs as water moves on the surface of the soil, leaching occurs as water moves downward through the soil.

☼ LEACHING

The process of water moving pesticides downward through the soil.

b. Factors Influencing Leaching. Several factors influence the leaching of pesticides.

- Water solubility. These include the water solubility of the pesticide. A pesticide that is dissolved in water can move readily with the water as it seeps through the soil.
- Soil structure and texture. Soil structure and texture influence soil permeability (how fast the water moves through soil) as well as the amount and persistence of pesticide adsorption to soil particles.
- Adsorption. Adsorption is probably the most important factor influencing leaching of pesticides. If a pesticide is strongly adsorbed to soil particles, it is less likely to leach, regardless of its solubility, unless the soil particles themselves move with the flow of water.

FACTORS WHICH INFLUENCE PESTICIDE LEACHING

- Water solubility of the pesticide.
- Soil structure.
- Soil texture.
- Adsorption.

c. The Concern. Groundwater contamination is a major concern associated with the leaching of pesticides from treated fields, mixing and rinsing sites, waste disposal areas, and manufacturing facilities. Refer to the next section in this lesson, "Groundwater Contamination" for information on how to prevent contamination by leaching pesticides.

8-9. CROP REMOVAL

Crop removal is another pesticide transfer process. When treated crops are harvested or animals are removed from an area for slaughter, the pesticide residues are removed with them and transferred to a new location. After harvest, many agricultural commodities are washed or processed. This washing or processing can remove or degrade much of the remaining residue.

☼ CROP REMOVAL

The process of pesticides being removed from an area along with the crop removed from that area.

8-10. MICROBIAL DEGRADATION

Microbial degradation occurs when microorganisms such as fungi and bacteria use a pesticide as a food source. Microbial degradation can be rapid and thorough under soil conditions favoring microbial growth.

- Those conditions include warm temperatures, favorable pH levels, adequate soil moisture, aeration (oxygen), and fertility.
- The amount of adsorption also influences microbial degradation.
- Adsorbed pesticides, because they are less available to some microorganisms, are more slowly degraded.

☼ MICROBIAL DEGRADATION

The process of microbes being degraded when microorganisms such as fungi and bacteria use a pesticide as a food source.

8-11. CHEMICAL DEGRADATION

Chemical degradation is the breakdown of a pesticide by processes not involving a living organism.

- The adsorption of pesticides to the soil, soil pH levels, soil temperature, and moisture all influence the rate and type of chemical reactions that occur.
- Many pesticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis in high pH (alkaline) soils or spray mixes.
- The addition of buffers to the spray mix can help slow hydrolysis reactions when some residual is desirable.

☼ CHEMICAL DEGRADATION

The breakdown of a pesticide by processes not involving a living organism.

8-12. PHOTODEGRADATION

Photodegradation is the breakdown of pesticides by the action of sunlight. Pesticides applied to foliage, the soil surface, or structures vary considerably in their stability when exposed to sunlight. Similar to other degradation processes, photodegradation reduces the amount of chemical present, which can subsequently reduce the efficacy of pest control.

☼ PHOTODEGRADATION

The process of the breakdown of pesticides by the action of sunlight.

Soil incorporation by mechanical methods during or after application, or by irrigation water or rainfall following application, can reduce pesticide exposure to sunlight.

SUMMARY OF PESTICIDE PROCESSES

Adsorption.
Absorption.
Volatilization.
Runoff.
Leaching.
Crop removal.
Microbial degradation.
Chemical degradation.
Photodegradation.

Section II. GROUNDWATER CONTAMINATION

8-13. GENERAL INFORMATION

a. Definition. Groundwater is the water beneath the earth's surface occupying the saturation zone, that is, the area where all the pore spaces in the rock or soil are filled with water. Groundwater is stored in water-bearing geological formations known as aquifers. Groundwater moves through aquifers and can be obtained at points of natural discharge such as springs or streams, or by drilling a well into the aquifer.

b. Water Table and Recharge. The upper level of the water-saturation zone in the ground is called the water table. The water table depth below the soil surface fluctuates throughout the year, depending on the amount of water removed from the ground and the amount of water added by recharge. Recharge is water that seeps through the soil from rain, melting snow, or irrigation.

c. Surface Water. Surface waters are visible bodies of water such as lakes, rivers, and oceans.

(1) Nonpoint and point source pollution. Both surface water and groundwater can be contaminated by nonpoint source pollution. This type of pollution generally results from land runoff, precipitation, acid rain, or percolation rather than from a discharge at a specific, single location (such as a single pipe). Nonpoint source pollution occurs when the rate at which pollutant materials entering waterbodies or groundwater exceeds natural levels.

(2) Point source pollution. Contamination from discharge at a single location (such as a single discharge pipe from a factory) is point source pollution.

d. Potential for Groundwater Pollution. The potential for groundwater pollution from improper agricultural practices is a significant concern.

- Inadequate handling of livestock waste storage facilities and improper application of manures and fertilizers can leave unacceptable levels of nitrates in groundwater.
- Pesticide residues, in particular, are receiving considerable national attention.
- Evidence suggests that in certain areas, agriculture's relative contribution to groundwater contamination may be significant.

8-14. PESTICIDES IN GROUNDWATER

a. Pesticides: Reach Groundwater or Degrade. Earlier, we discussed pesticide fate and the numerous transfer and breakdown processes that occur in the environment. Those processes help determine whether pesticides reach groundwater or are degraded prior to reaching these underground waters.

- Geological characteristics, such as the depth of the water table and the presence of sinkholes, are also critical.
- If the water table is close to the soil surface, there may be few opportunities for adsorption and degradation reactions to occur.

b. Extent of Pesticide Leaching.

(1) The possibilities. On the soil surface and within the first few inches of soil, pesticides can be:

- Volatilized.
- Adsorbed to soil particles.
- Taken up by plants.
- Broken down by sunlight, soil microorganisms, and chemical reactions.

(2) The extent. The extent of pesticide leaching is affected by both pesticide and soil properties. Weather conditions and management practices also affect leaching of pesticides through the soil. Too much rain or irrigation water can leach pesticides beyond the treatment area. A pesticide that is not volatilized, absorbed by plants, bound to soil, or broken down can potentially move through the soil to groundwater.

c. Movement of Groundwater. After pesticides reach groundwater, they may continue to break down, but at a much slower rate because of less available light, heat, and oxygen. The movement of groundwater is often slow and difficult to predict.

- Substances that enter the groundwater in one location can turn up years later in other locations.

- This means that your contamination eventually becomes someone else's contamination.

- If you contaminate your well, you likely contaminate your neighbor's well and many others also.

- A major difficulty in dealing with groundwater contaminants is that the sources of pollution are not easy to recognize.

- The problem is occurring underground, out of sight.

8-15. KEEPING PESTICIDES OUT OF GROUNDWATER

It is very difficult to purify or clean groundwater that has become contaminated. Treatment is complicated, time consuming, expensive, and often not feasible. The best solution to groundwater contamination is to prevent it. The pesticide applicator can reduce the potential for surface and groundwater contamination with the practices listed here.

a. Use Integrated Pest Management Programs. Pesticide use can be minimized by combining use of chemicals with other pest management practices.

b. Consider the Geology of Your Area. When planning pesticide applications, be aware of the water table depth.

- Know the permeability of the geological layers between the surface soil and groundwater.

- Sinkholes can be especially troublesome because they allow surface water to quickly reach groundwater.

c. Consider Soil Characteristics. Determine the susceptibility of your soil to leaching.

- Soil texture and organic matter content particularly influence chemical movement into groundwater.

- The leachability of the soil may determine whether a pesticide should be used in that area or not.

d. Select Pesticides Carefully. Remember, those pesticides which are highly soluble, relatively stable, and not readily adsorbed to soil tend to be the most likely to leach.

- Choose pesticides with the least potential for leaching into groundwater.

- Read labels carefully and consult a specialist from the Pesticide Hotline, Center for Health Promotion and Preventive Medicine, cooperative extension office, or your chemical dealer, if necessary.

e. Follow Label Directions. The label carries crucial information about the proper rate, timing, and placement of the pesticide in that container.

f. Calibrate Accurately. Equipment should be calibrated carefully and often. During the calibration procedure, check the equipment for leaks and malfunctions.

g. Measure Accurately. Carefully measure concentrates before they are placed into the spray tank.

- **DO NOT** "add a little extra" to ensure the pesticide will do a better job.

- Such practices only increase the likelihood of injury to the treated crop or animal, the cost of pest management, and the chance of groundwater contamination.

- Application of a pesticide at a higher rate than specified on the label is a violation of the law.

h. Avoid Back-Siphoning. The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemicals into the water supply.

- This practice also reduces the likelihood of the hose becoming contaminated with pesticides.
- Use a backflow prevention device when obtaining water directly from a well, public water supply, pond, or stream to dilute a pesticide.

CAUTION
BEFORE APPLYING PESTICIDES

- Follow principles of integrated pest management.
- Consider geology of the area.
- Consider soil characteristics.
- Select pesticides carefully.
- Follow pesticide label directions.
- Calibrate accurately.
- Measure accurately.
- Avoid back-siphoning.
- Consider weather and irrigation.
- Avoid spills - clean up spills.
- Select safe mixing areas.
- Dispose of wastes properly.
- Store pesticides away from water sources.

i. Consider Weather and Irrigation. If you suspect heavy or sustained rain, delay applying pesticides. The quantity of irrigation should be controlled to minimize the potential for pesticide leaching and runoff.

j. Avoid Spills - Clean Up Spills. When spills do occur, contain and clean them up quickly. Chemicals spilled near wells and sinkholes can move directly and rapidly into groundwater.

k. Select Safe Mixing Areas. Mix and load pesticides on an impervious curbed pad. Locate a water source with a backflow prevention device at the site.

l. Dispose of Wastes Properly. All pesticide wastes must be disposed of in accordance with local, state, and Federal laws. Read the label for instructions on the proper disposal of the container. Use all rinse water as diluent for the application of that pesticide.

m. Store Pesticides Away from Water Sources. Pesticide storage facilities should be situated away from wells, cisterns, springs, and other water sources. Storage facilities should not be located at a site that allows for the potential contamination of a water source (e.g., ground water, stream, lake, etc.).

Section III. EFFECTS ON NONTARGET ORGANISMS

8-16. AVOID CARELESS APPLICATION OF PESTICIDES

Applying pesticides carelessly can harm nontarget organisms that are beneficial to our environment. It is crucial that we protect these species. Such species include bees and other pollinators as well as fish and other wildlife.

8-17. BEES AND OTHER POLLINATORS

a. Benefits to Mankind. Bees and other pollinating insects are essential for successful production of many crops such as:

- Deciduous fruit trees.
- Most seed crops.
- Certain vegetables.

Many pesticides, particularly insecticides, are highly toxic to pollinating honeybees and wild bees. Be aware of how bee poisonings can occur, and how to prevent them.

b. Precautions. The following precautions reduce the chance of bee poisoning.

(1) No pesticides during bloom. **DO NOT** apply pesticides that are toxic to bees during bloom. Even shade trees and weeds should not be sprayed during bloom. Mow cover crops and weeds to remove the blooms prior to spraying.

(2) Select least harmful formulations. Select pesticides that are least harmful to bees and select the safest formulation.

- Dusts are more hazardous to bees than sprays.
- Wettable powders are usually more hazardous to bees than emulsifiable concentrates or water soluble formulations.
- Granular insecticide formulations are generally the least hazardous to bees. The hazard to bees increases, however, when insecticides are microencapsulated. The minute capsules can be carried back to the hive in much the same manner as pollen.

(3) Reduce drift. Reduce drift during application. Aerial applications usually are more hazardous to bees than are ground applications.

(4) Select appropriate time. Time pesticide application carefully. Evening applications are less hazardous then early morning. Both are safer than midday applications.

(5) **DO NOT** spray near bee hives. **DO NOT** treat near hives. Bees may need to be moved or covered before using an insecticide near colonies.

8-18. OTHER BENEFICIAL INSECTS AND MICROORGANISMS

The best way to avoid injury to beneficial insects and microorganisms, is to minimize pesticide usage. Selective pesticides should be used whenever possible and applied only when necessary as part of an integrated pest management program.

8-19. FISH AND OTHER WILDLIFE

a. Pesticide Harm. Pesticides can be harmful to all kinds of vertebrates. Most recognizable are the direct effects from acute poisoning. Fish kills often are a direct result of water pollution by a pesticide. Pesticides can enter water via:

- Drift.
- Surface runoff.
- Soil erosion.
- Leaching.
- In some cases, deliberate or careless release of pesticide directly into the water.

NOTE: Fish kills are most often caused by insecticide contamination of small ponds or streams with low water volume or turnover.

b. Bird Kills From Pesticide. Bird kills from pesticides can occur in a number of ways. Birds can ingest the toxicant in granules, baits, or treated seed. They may consume a treated crop or drink or use contaminated water. They may feed on pesticide contaminated prey.

8-20. BENEFICIAL PLANTS

Avoid applying herbicides in high winds to prevent injury to beneficial plants in adjacent areas.

8-21. CLOSING

You can avoid environmental damage by applying pesticides carefully, wisely, and according to the instructions on the product label.

EXERCISES, LESSON 8

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

Match the pesticide process in Column A with the correct definition/action in Column B. (Write the correct letter in the space next to the Column A number.)

COLUMN A Pesticide Process		COLUMN B Definition/Action	
___ 1.	Adsorption	a.	A process occurring over a sloping surface, carrying pesticides either mixed in water or bound to eroding soil.
___ 2.	Absorption	b.	Takes place when treated crops are harvested, the crops carrying pesticide residues to the new location.
___ 3.	Volatilization	c.	The breakdown of a pesticide by processes not involving a living organism.
___ 4.	Runoff	d.	The binding of chemicals to soil particles.
___ 5.	Leaching	e.	The breakdown of pesticides by the action of sunlight.
___ 6.	Crop removal	f.	Occurs when a solid or liquid turns into a gas.
___ 7.	Microbial degradation	g.	Occurs when microorganisms such as bacteria use a pesticide as a food source.
___ 8.	Chemical degradation.	h.	A process happening as water moves downward through the soil.
___ 9.	Photodegradation	i.	The process by which chemicals are taken up by plants and microorganisms.

10. Complete the following statements about groundwater.

a. Groundwater is _____

_____

_____

_____

b. The saturated zone is the area where

_____

_____

_____

_____

c. The water table may be defined as

_____

_____

_____

_____

d. Recharge could be described as

_____

_____

_____

_____

e. Nonpoint source pollution occurs when _____

_____

_____

_____

f. List two ways improper agricultural practices might contribute to groundwater pollution.

(1) _____

_____

_____

(2) _____

_____

_____

11. List five procedures which can be used to keep pesticides from contaminating groundwater.

a. _____

b. _____

c. _____

d. _____

e. _____

12. List three pesticide formulations which are most harmful to bees.

a. _____

b. _____

c. _____

13. What effect do insecticides have on pollinating honeybees and wild bees? _____

_____

_____

14. List five precautions to take to reduce the possibility of bee poisoning.

a. _____

b. _____

c. _____

d. _____

e. _____

END OF LESSON EXERCISES

LESSON ASSIGNMENT	
LESSON 9	Pesticide Toxicology.
LESSON ASSIGNMENT	Paragraphs 9-1 through 9-22.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to employ the principles of toxicology to pesticide use IAW Matsumura's *Toxicology of Pesticides*.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the reference listed above, you should be able to: 9-1. Identify the correct definition of each of the following: toxicity, hazard, LD50. 9-2. Identify the relative pesticide toxicity as measured by LD50 values. 9-3. List three major routes by which pesticides enter the human body. 9-4. Identify the symptoms of pesticide poisoning in these pesticide groups: ♦ Herbicides and fungicides. ♦ Organophosphates and carbamates. ♦ Chlorinated hydrocarbons. ♦ Pyrethrum and synthetic pyrethroids.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 9

PESTICIDE TOXICOLOGY

Section I. GENERAL INFORMATION

9-1. INTRODUCTION

With few exceptions, pesticides must be toxic to living organisms to be effective. They are specifically designed to be toxic to those organisms we consider pests. In many respects, however, all living organisms share many basic features. A substance that is toxic to one species will usually be somewhat harmful to another, including humans. Pesticides are poisonous to pests, and they may be poisonous to us as well.

9-2. TOXICITY AND HAZARD

This lesson explains how pesticides enter the body and how to protect yourself should contamination occur. An explanation of terms will help clarify this information. The words toxicity and hazard are often used interchangeably when describing the toxic effects of a pesticide. However, they are not the same.

Toxicity is a measure of the capacity of the pesticide to cause injury. It is a property of the chemical itself and its concentration. Hazard, on the other hand, is the potential for a chemical to cause injury. It reflects both the toxicity of the pesticide and the likelihood that significant exposure will occur in a particular situation. Pesticide applicators should be aware of the hazards associated with exposure to the chemical and not exclusively with the toxicity of the chemical itself.

Section II. EXPOSURE: HOW PESTICIDES ENTER THE BODY

9-3. ROUTES OF ENTRY

To cause an adverse effect (including death), a pesticide must first enter the body and reach a susceptible site. Three routes through which a pesticide can enter the human body are: the skin (dermal), the lungs (inhalation), and the mouth (oral).

9-4. DERMAL EXPOSURE

a. How Skin Entry Occurs. The skin is an important route of pesticide entry into the body. Dermal absorption may occur from a splash, spill, or drift when mixing, loading, applying, or disposing of pesticides. It may also result from exposure to plant residue or when cleaning or repairing contaminated equipment.

b. Poisoning from Small Amounts of Pesticides. Poisonings can occur even if only a small amount of chemical is allowed to remain on the skin. That small amount of pesticide is absorbed into the body, causing injury.

(1) Body parts absorb differently. Different parts of the body vary in their abilities to absorb pesticides. The groin, especially the scrotum, and the head tend to be highly absorptive. Nearly 100 percent of some pesticide formulations can pass through the skin covering these parts of the body. In contrast, the skin covering the hands is relatively resistant to absorption. Cuts, abrasions, and rashes enhance absorption in all parts of the body.

(2) Different pesticides absorb differently. Pesticide formulations vary in their absorbency through skin. In general, wettable powders, dusts, and granular pesticides are not as readily absorbed as are oil-based liquid formulations such as emulsifiable concentrates.

c. Eye Exposure. Under certain conditions and with certain pesticides, absorption through the eyes can be significant and particularly hazardous. Eyes are very sensitive to many pesticides. Considering their size, they are able to absorb surprisingly large amounts of chemical. Serious eye exposure can result from a splash or spill, drift, or rubbing the eyes with contaminated hands or clothing. Avoid this type of exposure by wearing protective eye covering, especially when indicated on the label.

9-5. INHALATION EXPOSURE

Protecting the lungs is especially important since pesticide powders, dusts, gases, vapors, or very small spray droplets can be inhaled during mixing, loading, or application, especially in confined areas. Once inhaled into the lungs, pesticides can enter the blood stream rapidly and completely. If inhaled in sufficient amounts, pesticides can cause damage to nose, throat, and lung tissue. The label will indicate the need for face masks or respirators when using specific pesticides.

9-6. ORAL EXPOSURE

a. Unlabeled Pesticides. Accidental oral exposure occurs most frequently when pesticides have been taken from the original labeled container and put into an unlabeled bottle or food container. Unfortunately, children are the most common victims. Children under the age of ten are the victims of at least half of the accidental pesticide deaths in the United States. Extreme caution should be used whenever applying any pesticide in an area where there are children, particularly when putting out baits.

b. Oral Exposure by Applicators. Oral exposure also occurs when liquid concentrates splash into the mouth during mixing or when cleaning equipment.

CAUTION

NEVER use your mouth to:

- **Clear a spray line.**
- **Begin siphoning a pesticide.**

The mouth should never be used to clear a spray line or to begin siphoning a pesticide.

- Chemicals can also be swallowed when eating, drinking, or smoking, or even licking one's lips.
- Since many pesticides are rapidly and completely absorbed by the intestinal tract, it is important to wash hands and face thoroughly before eating, drinking, or smoking.

CAUTION

DO NOT eat or smoke while handling pesticides.

Section III. TOXICITY AND POTENTIAL HEALTH EFFECTS OF PESTICIDES

9-7. DETERMINING TOXICITY

The toxicity of a particular pesticide is determined by subjecting test animals (usually rats, mice, rabbits, and dogs) to different dosages of an active ingredient and to each of its formulated products. From these studies:

- Acute and chronic toxicity and effects are determined.
- Signal words are assigned.
- Proper handling procedures are determined to reduce risk.

9-8. ACUTE TOXICITY AND ACUTE EFFECTS

a. Acute Toxicity. Acute toxicity is the capacity of a pesticide to cause injury from a single exposure. This is the most common type of pesticide poisoning. Acute toxicity can occur by at least three routes of entry.

(1) Dermal toxicity. Dermal toxicity can occur when the skin is exposed to chemicals.

(2) Inhalation toxicity. Inhalation toxicity can happen when test animals breathe vapors of the chemical.

(3) Oral toxicity. Oral toxicity is possible when an individual feeds the chemical to test animals.

b. Acute Toxicity. Acute toxicity is usually expressed as LD50 (lethal dose 50). LD50 is the amount of toxicant required to kill 50 percent of a test population of animals under a standard set of conditions. LD50 values of pesticides are recorded in milligrams of pesticide per kilogram of body weight of the test animal (mg/kg).

c. The LD50 Values. The LD50 values are used to compare the toxicity of different active ingredients as well as different formulations of the same active ingredient.

- The lower the LD50 value of a pesticide, the less it takes to kill 50 percent of a test population, and therefore the greater the acute toxicity of the chemical.
- Pesticides with the highest LD50 values are considered the least acutely toxic to humans when used according to the directions on the product label.

9-9. SIGNAL WORDS

All pesticides must carry a signal word on the label. The signal word indicates the relative toxicity of the active ingredient.

a. DANGER, POISON + SKULL AND CROSSBONES. Signal words indicate the toxicity of a pesticide.

- Those pesticides that are classified as "highly toxic," on the basis of either acute oral, dermal, or inhalation toxicity, must have two signal words **DANGER** and **POISON** (in red letters) and a skull and crossbones prominently displayed on the package label.
- **PELIGRO**, the Spanish word for danger, must also appear on the labels of highly toxic chemicals.
- Acute oral LD50 values for pesticide products in this group range from a trace to 50 mg/kg.
- As little as a few drops of such a material taken orally could kill a 150 pound person.

b. DANGER - No Skull and Crossbones. Some pesticide products carry the signal word **DANGER** without the skull and crossbones symbol. This occurs when possible skin irritation or eye effects are more severe than suggested by the acute toxicity (LD50) of the product.

c. WARNING. Pesticide products considered "moderately toxic" must have the signal words **WARNING** and **AVISO** (Spanish) displayed on the product label. Acute oral LD50 values range from 50 to 500 mg/kg. From 1 teaspoonful to 1 ounce of this material could kill a 150 pound person.

d. CAUTION. Pesticide products classified as either "slightly toxic or relatively nontoxic" are required to have the signal word **CAUTION** on the pesticide label. Acute oral LD50 values are greater than 500 mg/kg.

PESTICIDE TOXICITY SIGNAL WORDS

✓	**DANGER POISON (PELIGRO) + Skull & crossbones**	Highly toxic chemical
✓	**DANGER**	Possible skin irritation or eye effects more severe than acute toxicity level.
✓	**WARNING (AVISO)**	1 tsp. to 1 oz. could kill a 150 lb. person.
✓	**CAUTION**	Slightly toxic or relatively nontoxic.

9-10. CHRONIC TOXICITY AND CHRONIC EFFECTS

a. Definition. Chronic toxicity is the ability of a pesticide to cause injury from repeated, prolonged exposure to small amounts of the chemical. There are a number of pesticides which cause this type of effect. Chronic toxicity is very dangerous because pesticide applicators do not realize anything is wrong until injury has occurred. Applicators should remember that the absence of any immediate effect is not necessarily the same as safe use.

REMEMBER

Absence of immediate effect DOES NOT MEAN safe use.

b. Determining Chronic Toxicity. The chronic toxicity of a pesticide is determined by subjecting test animals to long-term exposure of an active ingredient. The harmful effects that occur from small doses repeated over a period of time are termed chronic effects. Some of the suspected chronic effects from exposure to certain pesticide include:

- Birth defects (teratogenesis).
- Toxicity to a fetus (fetotoxic effects).
- Production of tumors (oncogenesis), either benign or malignant.
- Genetic changes (mutagenesis).
- Blood disorders.
- Nerve disorders.
- Fertility effects.

Pesticides must include a chronic toxicity warning statement on the product label if chronic effects may occur. The chronic toxicity of a pesticide is more difficult to determine through laboratory analysis than the acute toxicity.

c. Human Poisoning from Pesticides. Poisoning symptoms may appear almost immediately after exposure or may be delayed for several hours, depending on the chemical, dose, length of exposure, and the individual.

- It is prudent to minimize exposure to pesticides as much as possible, due to the variety of effects that pesticides can cause and the amount of time it may take for the effects to appear.
- Regardless of how trivial the exposure may seem, if poisoning is present or suspected, obtain medical advice at once.

Section IV. TOXICOLOGY OF PESTICIDE GROUPS

9-11. INSECTICIDES

Symptoms differ with various insecticides, but all are dependent on both the amount and timing of exposure.

9-12. ORGANOPHOSPHATES AND CARBAMATES (MALATHION, VAPONA, CARBARYL)

a. General. Insecticides of most concern are the organophosphates and carbamates which inhibit cholinesterase, a chemical critical for normal functioning of the nervous system.

b. Immediate vs. Delayed Cholinesterase Inhibition. Symptoms may begin almost immediately after exposure to direct cholinesterase inhibitors such as mevinophos or furadan. Symptoms may be delayed several hours, however, after an equal exposure to a delayed cholinesterase inhibitor such as parathion, guthion, or phorate (thimet). Onset of symptoms more than 12 hours after exposure generally excludes organophosphate or carbamate insecticide poisoning, unless it is chronic poisoning from small repeated exposures.

c. Symptoms. The symptoms most commonly reported, which often appear in progression and depend, in part, on whether the chemical was touched, inhaled, or ingested, are:

(1) Mild symptoms. Headache, dizziness, weakness, anxiety, tremors of tongue and eyelids, blurred vision are all mild symptoms.

(2) Moderate symptoms. Included are nausea, salivation, tearing, abdominal cramps, vomiting, sweating, muscular twitching.

(3) Severe symptoms. Diarrhea, pinpoint eye pupils, breathing difficulty, cyanosis, loss of sphincter control, convulsions, coma are severe symptoms.

9-13. CHLORINATED HYDROCARBONS (DDT, METHOZYCHLOR, ETHYLAN)

a. Mode of Action. The mode of action varies according to chemical. Some of these chemicals alter ion permeability in the nervous system.

b. Symptoms.

- Vomiting.
- Trembling or shaking.
- Muscular weakness.

9-14. PYRETHRUM AND SYNTHETIC PYRETHROIDS (PYRETHRIN, RESMETHRIN)

a. Mode of Action. These chemicals alter ion permeability in the nervous system.

b. Symptoms.

- Contact dermatitis.
- Asthmatic reactions.
- Other allergic reactions.

9-15. PETROLEUM PRODUCTS (DORMENT OILS)

a. Mode of Action. High volatility produces coughing and nausea. Aspiration of a dormant oil results in thin oil film on the lung surface and possible suffocation.

b. Symptoms.

- Nausea.
- Coughing.
- Vomiting.
- Weakness.
- Dizziness.
- Slow and shallow breathing.

9-16. INORGANICS (SULFUR, ARSENIC)

a. Mode of Action. Heavy metals bind enzyme proteins on the cellular level and cause inflammation of the gastrointestinal tract endothelium.

b. Symptoms.

- Vomiting.
- Bloody diarrhea.
- Headache.
- Dizziness.
- Chills.
- Cramps.

9-17. HERBICIDES AND FUNGICIDES

a. General Information. Herbicides and fungicides are designed as "plant poisons." Human exposure to toxic levels results in a variety of general symptoms and signs of poisoning. These vary with the herbicide or fungicide, the amount absorbed, and the general health condition of the individual. Some of the symptoms begin immediately upon exposure while others are delayed for several hours or even days. Some of the most common symptoms and signs are listed here.

b. Dermal Contact.

- Skin irritation (drying and cracking).
- Skin discoloration (reddening or yellowing).
- Itching.

c. Inhalation.

- Burning sinuses.
- Throat and lung problems, accompanied by coughing.
- Hoarseness.
- Upper respiratory congestion.

d. Ingestion.

- Mouth and throat irritation.
- Chest pains.
- Nausea (stomach ache).
- Diarrhea.
- Muscle twitching.
- Sweating.
- Headache.
- Weakness.

Section VI. MEDICAL SURVEILLANCE

9-18. AR 40-5

In accordance with Section 10-15, chapter 10, AR 40-5, all personnel known as pesticide applicators will be included in medical surveillance, health education, and respiratory protection programs as part of the occupational health program.

9-19. CHOLINESTERASE TEST, URINE AND BLOOD ANALYSIS

Cholinesterase tests are used only for cholinesterase-inhibiting insecticides: organophosphates and carbamates. Urine and blood analysis, together with symptoms, are used to diagnose most herbicide, fungicide, and noncholinesterase inhibiting insecticide exposure and poisonings.

Section VII. FIRST AID INSTRUCTIONS

9-20. WORK WITH SOMEONE

When you are working with pesticides, it is always best to work with someone. Arranging to have someone with you may sometimes be an inconvenience, and it may seem like an unnecessary precaution--until something happens.

9-21. BEGIN FIRST AID TREATMENT IMMEDIATELY

If you or someone with you is exposed to a pesticide, immediately begin first aid treatment for yourself and then assist the victim in any way you can. Always be careful not to contaminate yourself. If there is any cause to seek medical attention, either call a doctor or take the victim directly to a doctor. **Take the pesticide label or labeled container with you.**

9-22. FIRST AID TREATMENT

First aid treatment varies according to the type of exposure. You should become thoroughly familiar with all of the appropriate procedures. Learn them ahead of time; you probably won't have the time or the opportunity to look them up when you really need them.

a. Dermal Exposure.

- Remove all contaminated clothing.
- Drench skin with water.
- Wash thoroughly including hair, if necessary; detergents and commercial cleansers are better than soap.
- Rinse thoroughly with lots of soap and water.
- Dry and wrap victim in a blanket.
- If chemical burns of the skin have occurred, cover area loosely with a clean, soft cloth. Avoid the use of ointments, greases, powders, and other medications.

b. Inhalation Exposure.

- Get to fresh air immediately.
- If you are with someone who has been poisoned, move the victim to fresh air immediately.
- Loosen all tight clothing.
- If breathing has stopped or is irregular, give mouth-to-mouth resuscitation.
- Keep the victim as quiet as possible.
- Prevent chilling (wrap in blankets, but do not overheat).
- If you are with a victim who is having convulsions, watch their breathing and protect them from falling and striking their head. Keep their chin up so their air passages will remain free for breathing. Do not put anything in their mouth.

- **DO NOT** give alcohol in any form to the victim.

CAUTION

When removing a victim from an inhalation hazard, take appropriate respiratory protection measures.

c. Eye Exposure.

- Hold eyelids open and wash eyes with a gentle stream of clean running water. Use large amounts of water. Do so immediately; delay for even a few seconds greatly increases the possibility of injury. Continue washing for 15 minutes or more.
- **DO NOT** use medications in the wash water--use pure water.

d. Oral Exposure.

- If a pesticide has gotten into your mouth, but has not been swallowed, rinse your mouth with large amounts of water.
- If the pesticide has been swallowed, the most important consideration is whether or not to induce vomiting; the decision must be made quickly and correctly. Follow the label directions for first aid.
- Get to a hospital as soon as possible; do not waste a lot of time attempting to induce vomiting.

EXERCISES, LESSON 9

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List three major routes by which pesticides enter the human body.

   a. _____

   b. _____

   c. _____

2. The toxicity of a particular pesticide is determined by _____

   _____

   _____

3. Acute toxicity, the most common type of pesticide poisoning, is _____

   _____

   _____

   _____

4. Acute toxicity, the most common type of pesticide poisoning, may be defined as

   _____.

5. The LD50 values are used to _____

_____

_____

6. Signal words--DANGER, POISON, PELIGRO, WARNING--indicate _____

_____

_____

7. Chronic toxicity is _____

_____

_____

_____

8. List four suspected chronic effects from exposure to certain pesticides,

a. _____

b. _____

c. _____

d. _____

9. Symptoms of exposure to toxic levels of herbicides and fungicides vary with the:

a. _____

b. _____

c. _____

10. Your partner is exposed to toxic levels of a pesticide which he has inhaled. What is the first thing you do? _____

_____

_____

_____

11. Removing all contaminated clothing and drenching the person's skin with water is part of the first aid treatment for _____ exposure to toxic levels of a pesticide.

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 10	Pesticide Classification and Formulation.
LESSON ASSIGNMENT	Paragraphs 10-1 through 10-34.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to select the appropriate type and class of pesticide for a given pest management situation IAW TM 5-632, TM 5-629, TIM 24.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 10-1. Identify pesticide classifications used to control particular kinds of pests. 10-2. Identify three ways pesticides are classified based upon the way pesticides enter a pest. 10-3. Select the chemical classification groups for pesticides and examples of each group to include both trade names and common names of selected pesticides. 10-4. Describe the properties of the following formulation. ◆ Emulsifiable concentrates. ◆ Flowables. ◆ Solutions. ◆ Aerosols. ◆ Micro-encapsulated pesticides. ◆ Dusts. ◆ Granules. ◆ Wettable powders. ◆ Soluble powders. ◆ Water dispersable granules. ◆ Baits. ◆ Fumigants. ◆ Adjuvants. 10-5. Identify the factors that effect the decision to combine pesticides in a tank.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 10

PESTICIDE CLASSIFICATION AND FORMULATION

Section I. GENERAL INFORMATION

10-1. INTRODUCTION

Pesticides are substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating pests, or intended for use as a plant regulator, defoliant, or desiccant. Pesticides are a mixed blessing.

- For example, they contribute significantly to agricultural productivity and to improved public health by reducing crop damaging and disease-carrying pests.
- However, they can adversely affect people, nontarget organisms such as fish and wildlife, and the environment.
- A pesticide may be defined more specifically as any chemical used to directly control pest populations or to prevent or reduce pest damage.

10-2. CLASSIFICATIONS

Pesticides are classified using a number of different methods. Each serves specific purposes. The four most common methods of classifying pesticides are based on:

- The group of pests managed by the pesticide.
- How the pesticide works.
- The chemical nature of the pesticide.
- The pesticide formulation.

10-3. TYPES OF PESTS MANAGED

This pesticide group system is as follows:

Pesticide Classification	Pests Managed
Insecticide	Insects & other related animals
Acaricide	Mites, ticks, & spiders
Miticide	Mites
Nematicides	Nematodes
Fungicide	Fungus
Bactericide	Bacteria
Herbicide	Weeds
Rodenticide	Rodents
Avicide	Birds
Piscicide	Fish
Molluscicide	Slugs & Snails
Ovicide	Eggs of organisms
Predacide	Vertebrates

Figure 10-1. Pesticide groups and the pest group managed.

10-4. HOW PESTICIDES WORK

Many synthetic organic pesticides work in one or more of the ways listed in Figure 10-2. Read the pesticide label to find out how the pesticide you are using works. These common terms classify pesticides based on how they work:

a. Protectants. Pesticides applied to plants, animals, structures, and products to prevent pest establishment are protectants.

b. Sterilants. Pesticides that manage pests by rendering them incapable of normal reproduction or kill all forms of life in the soil are sterilants.

c. Broad-spectrums. Broad-spectrums are pesticides that control two or more pests of a particular crop. They are sometimes labeled as multipurpose chemicals. A material capable of controlling scab, powdery mildew, and mites on apples, for example, is broad-spectrum.

This category of pesticides is somewhat more general than the others since a broad-spectrum pesticide may be a protectant, an eradicant, or systemic in its action.

d. Contacts. These are pesticides that kill pests simply by contacting the pest.

e. Systemics. Pesticides that are absorbed by one part of the animal or plant and distributed internally to other parts of the plant or animal. For example, a systemic herbicide is absorbed by roots or foliage and carried throughout the plant.

f. Fumigant. Fumigant pesticides kill the pests by giving off a toxic gaseous vapor.

Pesticide	Pests Managed
Protectant	Prevents pest establishment
Sterilant	Makes pest: -- Incapable of reproduction. or -- Renders soil incapable of supporting life.
Broad-spectrum (multipurpose chemicals) .	Controls two or more pests of a particular crop.
Contact	Kills by contact with pest.
Systemic	Absorbed by pest and distributed to pest internally.
Fumigant	Gives off a toxic gaseous vapor

Figure 10-2. Pesticides classified according to how they work.

Section II. PESTICIDE CHEMISTRY

10-5. INORGANIC PESTICIDES

Pesticides can be divided into two chemical groups: the inorganic and organic compounds.

a. Description. Inorganic pesticides are of mineral origin and therefore do not contain carbon. They commonly contain either arsenic, copper, boron, mercury, sulfur, tin, or zinc. Examples are sulfur dust, Bordeaux mix, and Paris green. Inorganic pesticides are widely used today, primarily to manage plant diseases.

b. Toxicity. Inorganic pesticides are not, however, very specific in their activity and may be toxic to a wide range of organisms, a characteristic which is often not desirable. They are generally less effective than many of the organic compounds. Some do offer the advantage of relatively low acute toxicity to humans, although compounds containing lead, mercury, and arsenic have generated widespread health-related and environmental concerns, and their use has been either totally banned or severely curtailed. Inorganic pesticides also contain hydrogen and often oxygen, nitrogen, phosphorus, sulfur, or other elements.

10-6. ORGANIC PESTICIDES

a. Growth of Organic Pesticides Since the 1940s. Most pesticides in use today are organic compounds. A small number of organic pesticides are either derived or extracted directly from plants (botanicals, e.g., rotenone, nicotene, pyrethrums, and strychnine). Most, however, are synthetic or man-made compounds. It is these chemicals that have been primarily responsible for the rapidly expanding use of pesticides since the 1940's. They are often extremely effective and easy to use, relatively inexpensive, and some are quite specific in their activity.

b. Health and Environmental Concerns. Organic pesticides have, however, been the principal focus of health and

environmental concerns and have been primarily responsible for problems associated with pesticide use and misuse. The synthetic organic pesticides (i.e., manmade, carbon containing chemicals) include:

- The chlorinated hydrocarbons.
- Organophosphates.
- Carbamates.
- Synthetic pyrethroids.
- Phenoxy herbicides.
- Fungicides.
- A number of other chemical classes.

10-7. MICROBIAL PESTICIDES

a. Description. A distinct group of pest management agents are the so-called microbial pesticides. These are simply bacteria, viruses, and fungi which cause disease in given pest species. Although they may occur naturally in certain areas, they may be intentionally introduced by humans in sufficient quantities so that a relatively high level of control becomes possible.

b. Process. There is some question as to whether microbial pesticides should legitimately be considered pesticides, although their methods of application are usually similar to those used for more traditional pesticides. Their activity tends to be highly specific and often virtually harmless to nontarget species.

c. Registered Microbial Pesticides. There are, however, only a few microbial pesticides registered for use at this time, and their success has been limited. Perhaps the best known example is the bacterium, *Bacillus thuringiensis* (Bt), which has been used effectively against some species of caterpillars (Bt var. *kurstaki*) and mosquito larvae (Bt var. *israelensis)*.

10-8. IMMATURE GROWTH REGULATORS (IGR)

a. Description. A relatively new class of pesticides are immature growth regulators. IGRs mimic natural insect hormones that function in the maturation process. These pesticides have little or no toxicity for vertebrates or plants. They have high target specificity and have little effect on nontarget species when applied properly. Some of the IGRs have long-lasting residual effect, especially when applied indoors. The IGRs currently registered with the EPA are synthetic analogs of either insect juvenile hormone (JH) or ecdysone.

(1) Juvenile hormone. These are the most common IGRs in use today. Juvenile hormone prevents maturation of insects to reproductive adults during immature molts. Exposure of nymphs or larval insects to these chemicals prior to the fourth instar has one of two results: prevents the insects from maturing to the adult stage or produces insects that are sterile adults. Formulations containing methoprene, kinoprene, and hydroprene are commonly used to control a wide variety of insects.

(2) Ecdysone analogs. Ecdysone, essential for insect molting, prevents the production of chitin. Exposure of molting insects to ecdysone mimics prevents chitin production following the molt. Insects are then susceptible to desiccation and attack by pathogens. Diflubenzuron is a chitin inhibitor in common use today. It has a high host range and a long residual. Because of these facts, pesticides containing diflubenzuron are classified as "Restricted Use" by the EPA.

b. Use. The use of IGRs is increasing because of their low vertebrate toxicity. In some situations, they can provide very effective, long-lasting control.

- However, since they do not kill adult insects, IGRs do not result in a fast knock-down of the insect population.
- This is especially true of formulations containing hydroprene.
- Therefore, IGRs are sometimes combined with a carbamate or organophosphate to effect a quick kill.

Section III. PESTICIDE FORMULATIONS

10-9. PESTICIDE FORMULATIONS: ACTIVE INGREDIENTS AND INERT INGREDIENTS

The component of a pesticide that controls the target pest is called the active ingredient (a.i.). Before a pesticide product is sold, active ingredients are mixed with liquid or dry inert ingredients (non-pesticidal). Although inert ingredients do not kill the pest, they may be capable of adverse environmental and human health effects. Mixtures of active and inert ingredients are pesticide formulations. Formulations make an active ingredient:

- More convenient to handle.
- Safer, easier, and more accurate to apply.
- In some cases, more attractive to the pest.

FORMULATION TYPES

- ✓ Liquid formulations.
- ✓ Dry formulations.
- ✓ Bait.
- ✓ Fumigants.
- ✓ Adjuvants.

10-10. FORMULATIONS

It is important to choose the formulation that is best for a particular job based on its effectiveness, cost, practicality, and relative safety to you, your installation, and the environment. The following are some of the considerations which are important in choosing a formulation:

- Some formulations require constant spray tank agitation; others do not.
- Dusts and granules do not require water for application, but it is often difficult to accurately calibrate the equipment and achieve uniform distribution.
- The potential hazard to the applicator, the potential for drift, and environmental contamination vary substantially among formulations.
- Formulations sold as liquids are easier to measure in the field than dry ones.
- Dry formulations are generally less affected by subfreezing temperatures during storage than liquid formulations.
- The price per pound of active ingredient varies for different formulations.

Section IV. LIQUID FORMULATIONS

LIQUID FORMULATIONS

- -- Emulsifiable concentrates.
- -- High concentrate liquids and spray concentrates.
- -- Low concentrate liquids.
- -- Flowables.
- -- Solutions.
- -- Water-soluble concentrates.
- -- Aerosols.
- -- Micro-encapsulated pesticides.

10-11. EMULSIFIABLE CONCENTRATES (EC)

a. Definition. Emulsifiable concentrates are concentrated oil solutions of technical grade material with enough emulsifier added to make the concentrate mix readily with water for spraying. The emulsifier is a detergent-like material that makes possible the suspension of microscopically small oil droplets in water to form an emulsion.

b. The Process. When an emulsifiable concentrate is added to water, the emulsifier causes the oil to disperse immediately and uniformly throughout the water, if agitated, giving it an opaque or milky appearance. This oil-in-water suspension is a normal emulsion. There are a few rare formulations of invert emulsion, which are water-in-oils suspensions, and are opaque in the concentrated form, resembling salad dressing or face cream.

c. Advantages.

- High concentration means price per pound of active ingredient is relatively low, and the product is easy to handle, transport, and store.
- Not abrasive, thus less wear and tear on equipment.
- If properly formulated, should remain suspended without further agitation for several days after dilution with water.
- Little visible residual on finished surfaces.

d. Disadvantages.

- High concentration makes it easy to overdose or underdose through mixing or calibration errors.
- Phytotoxicity hazard is usually greater.
- Easily absorbed through skin.
- Solvents may cause rubber or plastic hoses, gaskets, pump parts, and surfaces to deteriorate.
- May cause pitting or discoloration of painted finishes and may stain carpets.
- May be corrosive.

10-12. HIGH CONCENTRATE LIQUIDS, SPRAY CONCENTRATES

These formulations may be thought of as special EC formulations. They usually contain a high concentration of the active ingredient, often eight or more pounds per gallon. Most are designed to be mixed with water or oil. They contain chemicals that allow the formulation to wet, spread, and stick well. Ultra-low-volume concentrate materials are designed to be used directly without further dilution, and they may contain only the pesticide itself.

10-13. LOW CONCENTRATE LIQUIDS

These formulations contain low amounts of the active ingredient and are usually solutions prepared to be used as purchased, with no need for further dilution. This type of formulation is most often used for managing household pests, moth-proofing, or as a livestock spray or a spray in barns.

10-14. FLOWABLES (F OR L)

a. Description. Some active ingredients can be manufactured only as a solid, or, at best, semisolid material. They usually have relatively low solubility in water or other organic solvents. These pesticides are often formulated as flowable liquids. The active ingredient is very finely ground and suspended in a liquid along with special suspending chemicals and additives.

b. Use. This formulation is mixed with water or liquid fertilizer to form suspensions which require moderate agitation in the spray tank. Flowables seldom clog spray nozzles and are usually as easy to handle as emulsifiable concentrates formulations. There are fewer phytotoxicity problems with flowables than with emulsifiable concentrates.

- Advantages.
  - -- Stays in suspension longer than ordinary wettable powders.
  - -- Easy to handle and apply.
- Disadvantages.
  - -- Require moderate agitation.
  - -- May leave a visible residue.

10-15. SOLUTIONS(S)

Some active ingredients are completely soluble in water or organic solvents and, in their original state, are liquids. The pesticide is formulated in an appropriate solvent or water and exists as a true solution or in a molecular state. Solutions, if properly prepared for special uses, do not leave unsightly residues and will not clog spray equipment. Some formulations of this type can damage plants, in which case, other formulations must be used.

a. Advantages.

- Liquid mixed molecularly without settling out.
- Most rapidly absorbed through insect cuticle.
- Better penetration of crevices.
- Better adhesion to greasy surfaces because of better storage stability.

b. Disadvantages.

- Readily absorbed through the human skin.
- Costly diluent (diesel oil, kerosene, mineral oil, organic solvent).
- Fire risk.
- Solvent damage to asphalt, rubber, plastic, tile floor, and some paints.
- Quickly absorbed by porous surfaces, making less available to walking insects.

10-16. WATER-SOLUBLE CONCENTRATES (WS)

The active ingredient in water-soluble concentrates is soluble in water and is formulated either with water or with a solvent such as alcohol which mixes readily with water. When the formulations are added to water in the spray tank, they form a true solution and require no further agitation after they are mixed. Water-soluble concentrates are often salt or amine solutions such as paraquat or 2,4-D amine.

10-17. AEROSOLS

a. Description. The active ingredient of aerosols is in a liquid formulation, in a can, under pressure. One or more pesticides may be in the same formulation. The propellent drives the formulation out through a fine spray opening. The percentage of active ingredient is usually very low in aerosols.

b. Use. Convenience of use is the major advantage. Aerosols are mainly used in the garden and home. In addition to pressurized aerosols, there are thermal and mechanical aerosols which are used in special situations.

c. Advantage.

- Excellent for small areas and home use.

d. Disadvantages.

- Safety factor with children.
- Will explode if placed in high heat or fire.

10-18. MICRO-ENCAPSULATED PESTICIDES

a. Description. Micro-encapsulated pesticides are a relatively new method of formulating pesticides. The active ingredient is encased in extremely small capsules made of inert synthetic substances. The capsules are then suspended in a liquid. Application is made with conventional sprayers after diluting the formulation with water.

b. Use. The applied pesticide is released gradually over a period of time. The principle is similar to that used for slow-release cold medicines. Encapsulated materials can be handled with relative ease and safety and are effective for a longer time than other formulations of the same active ingredient. They may, however, pose a significant hazard to bees since capsules may be taken back to the hive with pollen.

c. Advantages.

- Applied at low concentration.
- Increased safety to applicator.
- Easy to mix, handle, and apply.
- Sustained release of insecticide over time.

d. Disadvantages.

- Extended life, continual release.
- Hazard factor with children and pets.

Section V. DRY FORMULATIONS

DRY FORMULATIONS

- Dust.
- Granules.
- Wettable powders.
- Soluble powders.
- Water dispersable granules.

10-19. DUSTS (D)

A dust formulation usually consists of 1 to 10 percent of the active ingredient mixed with an inert material such as a talc, clay, powdered nut hulls, or volcanic ash. All the ingredients are finely ground to a fairly uniform particle size range. Adjuvants are often added so that the formulation will store well and handle properly.

a. Application. Some active ingredients are prepared as dusts because they are safer for crops in this form than if they were emulsifiable concentrates. Dusts are always used dry and should never be mixed with water. The very small particles in dusts make them subject to drift into nontarget areas during application. Always apply them carefully, and never apply them under windy conditions. It is frequently difficult to achieve accurate and adequate coverage with dust formulations when applied to plant foliage. They are best applied to wet foliage since dusts are easily washed or blown off treated surfaces by wind or rain.

b. Process. Dust formulations are available for use on seeds, plants, and animals. For vertebrate animal management, dusts can be applied in small patches or burrows, so the animal comes in contact with them. The animals are killed as they swallow the pesticide while cleaning their feet and fur.

c. Hazards. Dust can present a significant hazard to the applicator because of the potential for inhalation of the dust particles even though the concentration of the active ingredient is low. Proper personal protective equipment for dust application is required.

d. Advantages.

- Can provide good results on porous surfaces.
- Penetrate hidden spaces such as wall voids and pipe ducts.
- Use around electrical junctions.
- Low cost often cheaper that aerosols.
- No odor.
- Non-staining/nontoxic to vegetation.
- Generally not absorbed through the skin.

e. Disadvantages.

- Danger of drift to nontarget areas.
- Easily inhaled.
- Unsightly indoors.

10-20. GRANULES (G)

a. Description. Granular pesticides overcome the disadvantages of dusts in their handling characteristics. The granules are small pellets formed from various inert clays and sprayed with a solution of toxicant to give the desired content. After the solvent has evaporated, the granules are packaged for use. Granular materials range in size from 20 to 80 mesh.

b. The Product. Only insecticides and a few herbicides are formulated as granules. They range from 2 to 25 percent active ingredient and are used almost exclusively in agriculture, although systemic insecticides as granules can be purchased for lawn and ornamental use. There are also granular mosquito larvacides.

c. Use. Granular materials may be applied at virtually any time of day, since they can be applied aerially in winds up to 20 mph without problems of drift, an impossible task with sprays or dusts.

d. Advantages.

- Ready to use, no mixing, simple application equipment.
- Particles settle quickly, and drift hazard is low.
- Persistent on porous surfaces and without solvent problems, reduce the loss of pesticide.
- Very useful for treatment of crawling insects around outside perimeter of buildings.
- Penetrate dense vegetation.

e. Disadvantages.

- Bulky to handle.
- Could be hazard to pets and children.

10-21. WETTABLE POWDERS (WP OR W)

a. Description. These are dry, powdered pesticide formulations that look like dusts. But, unlike dusts, they contain wetting and dispersing agents. Wettable powders are usually much more concentrated than dusts, containing 15 to 95 percent active ingredient. They are made to mix with water, and when mixed, form a suspension. Continual agitation is needed in the spray tank to keep the formulation in suspension since it does not form a true solution.

b. Wettable Powders and Emulsifiable Concentrates. Some pesticide products can be prepared as wettable powders but not as emulsifiable concentrates because of the nature of the active ingredient. Properly prepared wettable powder formulations spray well and do not clog nozzles. Most wettable powder formulations are less likely to damage plants then emulsifiable concentrates formulations. Wettable powders and emulsifiable concentrates are the formulations most widely used.

c. Advantages.

- Low cost.
- Easy to store, transport, and handle.
- Lower phytotoxicity hazard than other liquid formulation.
- Easily measured and mixed.
- Less skin and eye absorption than EC and other liquid formulation.
- Lasts longer in environment to ensure a residual action.

d. Disadvantages.

- Inhalation hazard to applicator while pouring and mixing the concentrated powder.
- Requires good and constant agitation (usually mechanical) in the spray tank.
- Residues may be visible.

- Most likely to clog the spray nozzle and cause wear (abrasive) to pumps and nozzle.

10-22. SOLUBLE POWDERS (SP)

Soluble powders, like wettable powders, are dry formulations. But, when soluble powders are added to water, they will dissolve and form true solutions. Agitation in the spray tank is sometimes required to get them into solution after which no more agitation is needed. Not many soluble powders formulations are available.

10-23. WATER DISPERSABLE GRANULES (WDG)

a. Description. Water-dispersible granules (also called "dry flowables") are finely-divided powders that are formulated into concentrated, dustless granules. The formulation is a relatively new one and is increasing in popularity. Water-dispersible granules form a suspension in water or liquid fertilizer and require some agitation to maintain a uniform spray mixture.

b. Use. The principle advantage of this formulation is that, although it is sold in the dry form, it is not a dust and can be handled with great ease and safety. Water-dispersible granules are not intended for direct application through a granular applicator. Unlike granules designed for application in the dry form, these formulations contain a high percentage of active ingredient, often as much as 75 to 90 percent.

Section VI. OTHERS BAITS--FUMIGANTS--ADJUVANTS

10-24. BAITS

a. Description. A bait formulation is an active ingredient mixed with an edible substance or some other attractant (water). The pest is killed by consuming a lethal dose of the bait's poison either in a single feeding or over a period of time.

b. Use. Baits are useful in managing mice, rats, and other rodents. They also are used with ants, cockroaches, flies, and other insects. Whole areas or simple spot treatments can be done with baits. However, placement of the bait in locations where it is likely to be consumed is of obvious importance. Baits can be used in buildings and outdoors. The percentage of active ingredient in bait formulations is quite low, usually below five percent.

c. Hazards to Nontarget Organisms. Since this method of application limits the amount of pesticide introduced into the environment, environmental contamination can be minimized. It is important to note that baits may be attractive to nontarget organisms. If a bait is not adequately selective, extra caution must be used to prevent nontarget organisms from reaching the bait, either through placement or use of screens, boxes, or other types of physical barriers.

10-25. FUMIGANTS

a. Description. Fumigants are pesticides or mixtures of pesticides which produce vapors (gases) that are toxic when absorbed or inhaled. Fumigants are not a type of formulation. The volatile nature of fumigants is a property of the chemicals themselves; it is not the result of a formulation process. Fumigants are formulated and sold as gases, gels, volatile liquids, emulsifiable concentrates, or granules. All fumigants volatilize when applied. Most result in 100 percent kill of all life, plant, and animals in the treated area.

b. Use. Soil fumigants can be used to manage nematodes, soil fungi, weeds, and soil insects. Fumigants are also important for managing stored grain pests. They are also sometimes used to control termites, especially dry Formosan termites.

c. Advantages.

- Unlike fogs, fumigants act as separate molecules. Molecules penetrate the material being fumigated and exit after the job is done. They leave no residue to contaminate food.

- Fumigants result in a quick and total kill of what they come in contact with..

d. Disadvantage.

- Inhaling fumigants is hazardous.

10-26. ADJUVANTS

a. Description. An adjuvant or additive is a chemical added to a pesticide principally to increase its effectiveness, although some adjuvants are designed to reduce phytotoxicity or drift.

b. Adjuvants Contained in Most Pesticide Formulations. Most pesticide formulations already contain a small percentage of adjuvants. Look at the following:

- Wetting agents and emulsifiers are often added so that the pesticide will mix with water or coat treated surfaces more effectively.
- Spreaders allow pesticides to spread evenly over treated surfaces.
- Stickers increase the adherence of the chemical to the treated surface, thus increasing its persistence, particularly under adverse weather conditions.
- Penetrants aid the absorption of a systemic pesticide by the plant.

Adjuvants are used most extensively in products designed for foliar applications.

c. Restrictions for Use. Adjuvants should normally be added only if recommended on the product label; otherwise, you are taking a risk. Some labels expressly prohibit the use of adjuvants. Always bear in mind that while you may be increasing the effectiveness of a particular pesticide, you may also be increasing the potential for excess residues, phytotoxicity, and perhaps harm to nontarget organisms and the environment.

Section VII. COMPATIBILITY OF PESTICIDES

10-27. COMBINING PESTICIDES IN A SPRAY TANK -- OR NOT

In some situations, applicators may attempt to manage more than one pest with a single application by combining pesticides in the spray tank. Such a practice can create problems. Sometimes these problems are serious and more costly than if the chemicals are applied alone. There is no question that product mixing requires:

- Extensive knowledge of pesticide formulations.
- Timing of application.
- Application technique.

10-28. BEFORE COMBINING PESTICIDES IN A SPRAY TANK

It is essential to determine the compatibility of the products involved. In simple terms, we are concerned about whether the mixtures can be used in combination without reducing the safety and effectiveness of the compounds.

a. Prior Considerations. Before combining any pesticides, check labels, product information sheets, company representatives, or Cooperative Extension Service personnel for information on compatibility of the products in question.

b. Pesticide Incompatibility. Before mixing pesticides, consider the physical, chemical, phytotoxic, placement, and timing areas of incompatibility.

10-29. PHYSICAL INCOMPATIBILITY

Physical incompatibility occurs when two or more pesticides are mixed together and the result is an unsprayable mixture because of excessive foaming, curdling, or a gummy deposit

on the bottom of the spray tank. Hard water and cold water can also cause some physical incompatibilities. In some cases these can be recognized in the spray tank before the mixture is sprayed. Problems associated with physical incompatibility can often be tested by mixing small batches of the mixtures in the same proportions and agitating them in a closed container such as a quart jar.

10-30. CHEMICAL INCOMPATIBILITY

Chemical incompatibility occurs when the pesticides are mixed, and the effectiveness of one or all of the compounds is reduced or destroyed.

- This happens frequently when materials with a high pH (such as lime) are added to the mixture.
- Chemical incompatibility is not evident in the spray tank, but becomes apparent when there is a lack of or reduced control.

10-31. PHYTOTOXIC INCOMPATIBILITY

Phytotoxic incompatibility occurs when product mixtures cause injury to plants sprayed with the mixture. This can happen even though each of the pesticides in the mixture, when sprayed separately, does not cause injury. As with chemical incompatibility, check all information on the pesticides for any warnings about this type of incompatibility. If in doubt, spray a small amount on a few plants and observe the effect, being sure to allow enough time for injury to develop.

10-32. PLACEMENT INCOMPATIBILITY

Even though the mixing of two or more chemicals to manage different pests may save time in application, the spray operator must be sure the chemicals are going to be placed where they will be effective. A good example of this type of incompatibility would be the mixture of a turf fungicide with an insecticide to manage grubs in turf. The fungicide needs to be deposited on the leaves, but the soil insecticide needs to be drenched into the soil where the soil grub will come in contact with it.

10-33. TIMING INCOMPATIBILITY

Pesticides must be applied when the pest is at a vulnerable stage of development. With many insects, diseases or weeds, this may be a relatively short period. It is of utmost importance when using two or more chemicals to manage different pests, that the mixture be applied at the correct time in the life cycle to be effective.

10-34. CONCLUSION

The pest control operator must consider many factors when selecting a pesticide formulation. He must consider the pest and its location or harborage. He must consider the risk for accidental exposure of nontarget organisms and environmental damage. He must consider his application equipment. All of these, together, will indicate the formulation that is best suited for the job at hand.

EXERCISES, LESSON 10

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List the four most common methods of classifying pesticides.

   a. _____

   b. _____

   c. _____

   d. _____

2. When does phytotoxic incompatibility occur? _____

   _____

3. List three advantages of using fumigants to control pests.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

4. The two major pesticide chemical groups are inorganic compounds and organic compounds.

   a. Inorganic compounds are made from

   _____.

   b. Organic compounds are synthetic or

   _____.

   c. Are inorganic pesticides or organic pesticides primarily responsible for problems with pesticide use and misuse today?

   _____.

Match the pesticide classification in Column A to the pest managed in Column B. (Write the correct letter in the space next to the Column A number.)

COLUMN A Pesticide Classification	COLUMN B Pest Managed
___ 5. Herbicide	a. Birds.
___ 6. Avicide	b. Mites, ticks, and spiders.
___ 7. Predacide	c. Weeds.
___ 8. Acaricide	d. Vertebrates.
___ 9. Molluscicide	e. Insects and other related animals.
___ 10. Insecticide	f. Slugs and snails.

Match the pesticide classification in Column A to the pesticide action in Column B. (Write the correct letter in the space next to the Column A number.)

COLUMN A Pesticide Class	COLUMN B Pesticide Action
___ 11. Adsorption	a. A process occurring over a sloping surface, carrying pesticides either mixed in water or bound to eroding soil.
___ 12. Broad-spectrum pesticide	b. Takes place when treated crops are harvested, the crops carrying pesticide residues to the new location.
___ 13. Systemic pesticide	c. The breakdown of a pesticide by processes not involving a living organism.
___ 14. Fumigant pesticide	d. The binding of chemicals to soil particles.
___ 15. Contact pesticide	e. The breakdown of pesticides by the action of sunlight.
___ 16. Sterilant pesticide	f. Occurs when a solid or liquid turns into a gas.

END OF LESSON EXERCISES

LESSON ASSIGNMENT	
LESSON 11	The Pesticide Label.
LESSON ASSIGNMENT	Paragraphs 11-1 through 11-17.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to perform pesticide operations within label specifications IAW AR 200-5 and DoD Dir 4150.7.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 11-1. Select the reference one should always consult prior to applying pesticides. 11-2. Identify the fourteen content areas of a pesticide label.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 11

THE PESTICIDE LABEL

11-1. INTRODUCTION

a. Information on the Label. The first action the pest controller should take before purchasing, mixing, or applying any pesticide is to **READ THE LABEL**. The product label is one of the most important tools for safe and effective use of pesticides. Pesticide manufacturers are required by law to put certain information on the label, information which when not followed can result in a pesticide accident and legal action against the violator. Labels are legal documents providing directions on how to mix, apply, store, and dispose of a pesticide product.

b. Parts of the Label. Some labels are very easy to understand; others are complicated. It is the user's responsibility to read and understand the label before buying, using, storing, or disposing of a pesticide. To help you better understand labels, each of the label components will be discussed in this section.

THE CONTENT AREAS OF THE LABEL

- Ingredient statement.
- Statement of use.
- Type of pesticide.
- Net contents.
- Manufacturer name and address.
- Registration numbers.
- EPA establishment numbers.
- Signal words and symbols.
- Precautionary statements.
- Statement of practical treatment in case of poisoning.
- Environmental hazards.
- Physical or chemical hazards.
- Reentry statement.
- Directions for product storage and disposal.

11-2. TRADE, BRAND, OR PRODUCT NAMES

a. Trade Names. Every manufacturer has trade names for their products. Most companies register each trade name as a trade mark and will not allow any other company to use that name without permission. Different trade names are used by different manufacturers, even though the products contain the same active ingredient. The brand or trade name shows up plainly on the front panel of the label and is the one used in advertisements and by company salespersons.

b. Brand Names. The brand name often indicates the type of formulation and the percentage active ingredient. For example, Sevin^{R} 50WP is a brand name. Sevin^{R} is the registered trade name and the formulation is a wettable powder containing 50 percent active ingredient.

11-3. INGREDIENT STATEMENT

a. Active Ingredients. Every pesticide label must list every active ingredient and its percentage in the container. Inert ingredients are not usually named, but the label must show what percentage of the total contents they comprise. The ingredient statement must list the official chemical and common names of the active ingredients. Let's discuss an example:

- Sevin^{R} 50WP.
- Active ingredient:
  carbaryl (1-naphthyl
  N-methyl carbamate) 50%
- Inert ingredients 50%.

b. Chemical Name. The chemical name is the complex name that identifies the chemical components and structure of the pesticide. This name must be listed in the ingredient statement on the label. For example, the chemical name of Sevin^{R} is 1-naphthyl N-methyl carbamate.

c. Common Name. Because chemical names are usually complex, many are given a shorter common name. Only those names officially accepted by the EPA may be used in the ingredient statement on the pesticide label. The official common name is usually followed by the chemical name in the list of active ingredients. The common name for Sevin^{R} is carbaryl. By purchasing pesticides according to the common or chemical names, you will be certain of getting the right active ingredient, no matter what the brand name or formulation.

11-4. USE CLASSIFICATION STATEMENT

Every pesticide product is classified by the EPA as either restricted use or unclassified/ general use. Every pesticide product classified restricted use must carry this statement in a prominent place at the top of the front panel of the pesticide label:

> RESTRICTED USE PESTICIDE.
> For retail sale to and use only by certified applicator or persons under their direct supervision and only for those uses covered by the certified applicator's certification.

11-5. TYPE OF PESTICIDE

The type of pesticide is usually listed on the front panel of the pesticide label. This short statement indicates in general terms what the product will control. Examples:

- Insecticide for control of certain insects on fruits, nuts, and ornamentals.
- Herbicide for control of woody brush and weeds.
- Fungicide for control of plant and animal pathogens.

11-6. NET CONTENTS

The front panel of the pesticide label shows how much product is in the container. This is expressed as pounds or ounces for dry formulations or as gallons, quarts, or pints for liquids. Liquid formulations may also list the pounds of active ingredient per gallon of product.

11-7. NAME AND ADDRESS OF MANUFACTURER

The law requires that the manufacturer or formulator of a product put the name and address of the company on the label. This tells you who made or sold the product.

11-8. REGISTRATION NUMBERS

An EPA registration number (e.g., EPA Reg. No. 999-000) must appear on all pesticide labels. This indicates that the pesticide product has been registered and its label approved by the EPA. In cases of special local needs, pesticide products may be approved for use in a specific state. These registrations are designated; for example, as EPA SLN No. MI-860009. In this case, SLN indicates "special local need," and MI means that the pesticide is registered for use in Michigan.

11-9. ESTABLISHMENT NUMBERS

An EPA establishment number (for example, EPA Est: No. 000) must also appear on the pesticide label. It identifies the facility that produced the pesticide in case a problem arises or the pesticide is found to have been adulterated in any way.

11-10. SIGNAL WORDS AND SYMBOLS

a. Signal Word. Every pesticide label must include a signal word. This important designation gives the user an indication of the relative toxicity of the product to humans and animals. Toxicity is one factor you should consider when choosing a pesticide.

b. Frequently Found Signal Words. The signal word must appear in large letters on the front panel of the pesticide label along with the statement, "Keep Out of Reach of Children." The following signal words may be found on pesticide labels.

- **DANGER-POISON, SKULL AND CROSSBONES.** These words and the symbol must appear (in red letters) on all products that are highly toxic by any route of entry into the body; the words and symbol indicate these are the most hazardous pesticides. Peligro, the Spanish word for danger, must also appear on the label.

- **DANGER/PELIGRO.** Products with this signal word can cause severe eye damage or skin irritation.

- **WARNING/AVISO.** These words signal that the product is moderately toxic orally, dermally, through inhalation, or causes moderate eye or skin irritation. Aviso, the Spanish word for warning, must also appear on the label.

- **CAUTION.** This word signals that the product is slightly toxic orally, dermally, through inhalation, or causes slight eye or skin irritation.

11-11. PRECAUTIONARY STATEMENTS

All pesticide labels contain additional statements to help applicators decide the precautions to take to protect themselves, their employees, and other persons (or animals) that could be exposed. Sometimes these statements are listed under the heading, "Hazards to Humans and Domestic Animals." They may be composed of several sections.

a. Routes of Entry Statements. The statements which immediately follow the signal word, either on the front or side panels of the pesticide label, indicate which route or routes of entry (mouth, skin, lungs) are particularly hazardous and need protection. Many pesticide products are hazardous by more than one route, so study these statements carefully. A DANGER signal word followed by "May be fatal if swallowed or inhaled" gives you a far different warning than, DANGER followed by "Corrosive - Causes eye damage and severe skin burns."

b. Specific Action Statements. These statements usually follow immediately after the route of entry statements. The specific action statements help prevent pesticide poisoning by recommending necessary precautions, protective clothing, and equipment. These statements are directly related to the toxicity of the pesticide product (signal word) and the routes of entry.

c. Protective Clothing and Equipment Statements. Pesticide labels vary in the type of protective clothing and equipment statements they contain. Many labels carry no statements at all. The best way to determine the correct type of protective clothing and equipment is to consider the signal word, the route of entry statements, and the specific action statements on the label.

11-12. STATEMENT OF PRACTICAL TREATMENT

This section of the label lists first aid treatments recommended in case of poisoning. All **DANGER** labels and some **WARNING** and **CAUTION** labels contain a note to physicians describing the appropriate medical procedure for poisoning emergencies and may identify an antidote. The label should always be available for emergencies. In the event of a pesticide poisoning, take the label to the hospital with you.

REMEMBER

For pesticide poisoning, take the label to the hospital with you.

11-13. ENVIRONMENTAL HAZARDS

Pesticides can be harmful to the environment. Some products are classified restricted use because of environmental hazards alone. Watch for special warning statements on the label concerning hazards to the environment.

a. Special Toxicity Statements. If a particular pesticide is especially hazardous to wildlife, it will be stated on the label. For example: "This product is highly toxic to bees," or "This product is toxic to fish." These statements alert pesticide users to the special hazards posed by use of the product. They should help applicators choose the safest product for a particular job and remind them to take extra precautions.

b. General Environmental Statements. Some of these statements appear on virtually every pesticide label. They are reminders to follow certain common sense actions to avoid contaminating the environment. The absence of any or all of these statements does not indicate that you do not need to take adequate precautions. Sometimes these statements follow a "specific toxicity statement" and provide practical steps to avoid harm to wildlife. Examples of general environmental statements include: "Do not apply when runoff is likely to occur," and "Do not apply when weather conditions favor drift."

11-14. PHYSICAL OR CHEMICAL HAZARDS

a. Special Hazards. This section of the label describes any special fire, explosion, or chemical hazards the product may pose. For example: "Flammable - Do not use, pour, spill, or store near heat or open flame. Do not cut or weld container."

b. Hazard Statements on the Label. Hazard Statements (hazard to humans and domestic animals, environmental hazards, and physical or chemical hazards) are not located in the same place on all pesticide labels.

- Some labels group them under the headings listed above.
- Other labels may list them on the front panel beneath the signal word.
- Still other labels list the hazards in paragraph form somewhere else on the label under headings such as "Note" or "Important."
- Prior to use, the label should be examined for these statements to ensure knowledgeable and safe handling.

11-15. REENTRY STATEMENT

Some pesticide labels contain a reentry interval precaution. This statement tells how much time must pass before people can reenter a treated area without appropriate protective clothing and equipment. Reentry intervals are set by both the EPA and some states. Reentry

intervals set by states are not always listed on the label; it is your responsibility to determine if one has been set. The reentry statement may be printed in a box under the heading "Reentry" or it may be in a section with a title such as "Important," or "Note," or "General Information."

11-16. DIRECTIONS FOR USE

a. Federal Law Restrictions for Pesticide Use.

(1) The restriction. Directly under the heading on every pesticide product label is the following statement:

"It is a violation of Federal law to use this product in a manner inconsistent with its labeling."

(2) Points of law. It is illegal to use a pesticide in any way not permitted by the labeling.

- A pesticide may be used only on the plants, animals, or sites named in the directions for use.
- You may not use higher dosages, higher concentrations, or more frequent applications.
- You must follow all directions for use, including directions concerning safety, mixing, diluting, storage, and disposal.
- You must wear the specified personal protective equipment even though you may be risking only your own safety by not wearing it.

WARNING

The use directions and instructions are not advice; they are requirements.

b. What Federal Law Allows. Federal law does allow you to use pesticides in some ways not specifically mentioned in the labeling. Unless you would be in violations of the laws of your state or tribe, you may:

- Apply a pesticide at any dosage, concentration, or frequency **less** than that listed on the labeling.
- Apply a pesticide against any target pest not listed on the labeling if the application is to a plant, animal, or site that is listed.
- Use any appropriate equipment or method of application that is not prohibited by the labeling.
- Mix a pesticide or pesticides with a fertilizer if the mixture is not prohibited by the labeling.
- Mix two or more pesticides, if all of the dosages are at or below the recommended rate.

11-17. STORAGE AND DISPOSAL

a. Instructions for Pesticide Storage. All pesticide labeling contains some instructions for storing the pesticide. These may include both general statements, such as "Keep out of reach of children and pets," and specific directions, such as "Do not store at temperatures below 32°F."

b. Instructions for Pesticide Disposal. Pesticide labeling also contains some general information about how to dispose of excess pesticide and the pesticide container in ways that are acceptable under Federal regulations. State and local laws vary, however, so the labeling usually does not give exact disposal instructions.

EXERCISES, LESSON 11

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. Before applying a pesticide, read the product _____.

2. The type of formulation and the percentage of active ingredient can often be determined from the _____ name.

3. The company's registered name for their product is a _____ name.

4. **TRUE or FALSE.** The instructions for use on the pesticide container are advice--not requirements. You do not have to follow these instructions. _____

Match the label part in Column A with the label information in Column B. (Write the correct letter in the space next to the Column A number.)

COLUMN A Label part		COLUMN B Label information
____ 5.	Chemical name	a. Product can cause severe eye damage or skin irritation.
____ 6.	Special hazards	b. Tells who made the pesticide.
____ 7.	Specific action statements	c. List of the official chemical and common names of the active ingredients in the pesticide.
____ 8.	Registration numbers	d. Identifies the chemical components and structure of the pesticide.
____ 9.	DANGER/PELIGRO	e. "Do not apply when weather conditions favor drift" is an example.
____ 10.	Statement of practical treatment	f. For sale to and use only by certified applicator or persons under their direct supervision.
____ 11.	General environmental statement	g. Indicates that the pesticide label has been approved by the Environmental Protection Agency.
____ 12.	Name and address of manufacturer	h. List of first aid treatments recommended in case of poisoning.
____ 13.	Ingredient statement	i. Describes any special fire, explosion, or chemical hazards the product may pose.
____ 14.	RESTRICTED USE PESTICIDE	j. Help prevent poisoning by recommending necessary precautions and protective clothing and equipment.

END OF LESSON EXERCISES

LESSON ASSIGNMENT	
LESSON 12	Safe Handling of Pesticides.
LESSON ASSIGNMENT	Paragraphs 12-1 through 12-25.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to Handle pesticides safely IAW AR 220-1, AR 200-5, TM 5-632, TIM 14, TIM 15, and MIL HDBK 1028/8A.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 12-1. Identify personal protective equipment used in mixing and dispersing pesticides. 12-2. Identify correct care and maintenance procedures for personal protective equipment. 12-3. Identify pesticide shop design requirements. 12-4. Select the most appropriate procedures for disposal of pesticides, residues, and contaminated containers. 12-5. Select in sequence emergency pesticide spill control procedures.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 12

SAFE HANDLING OF PESTICIDES

Section I. PROTECTION

12-1. INTRODUCTION

a. Decisions. Before you do a pesticide handling task, you need to make some important decisions. For any pesticide handling activity, you must decide how to ensure the safety of yourself, others, and the environment. Before you apply a pesticide, you must make several decisions about how to fit the application to your own pest control situation.

b. Personal Safety. The key to personnel safety when handling pesticides is to avoid exposure to them. Always keep personal clothing, food, drinks, tobacco products, and other belongings away from where pesticides are stored or handled. These items can become contaminated, poisoning you when you use them.

c. Hand Wash. When you take a break, wash your gloves on the outside, remove your gloves, and wash your hands and face thoroughly. Then, you can safely eat, drink, or smoke, if you wish. Avoid getting pesticide on yourself when you use the toilet. The skin in the genital area has been shown to absorb more

pesticides more readily than skin on any other area of the body. Take time to wash your hands thoroughly before using the toilet, and be careful not to contaminate yourself with pesticides that may be on the outside of your clothing.

d. Detailed Self-Protection. Be aware of other situations where you might be exposed to pesticides on the job. Protect yourself not only during mixing, loading, and application, but also during spill cleanup, repairing, or maintaining equipment, and when transporting, storing, or disposing of pesticide containers that are open or have pesticides on their outer surface. Use personal protective equipment when necessary to keep pesticide from getting on your skin or in your mouth, eyes, or lungs.

12-2. PROTECTIVE EQUIPMENT AND CLOTHING

a. Coveralls. Each pest controller requires a daily set of coveralls. Coveralls will be laundered at government expense or by a washer and dryer located in the pest control shop. They are **NOT** to be laundered at home. Coveralls are to be changed daily or more often, if necessary. Coveralls are worn outside of the boots and over the gloves to prevent pesticide from running down into the glove or boot in case of a spill on the coveralls.

b. Rubber Boots. Rubber boots are the approved footgear for pest controllers since they can be cleaned with detergent and water and air-dried upside down after each use. Leather boots and tennis shoes are not approved as they cannot be decontaminated since pesticide is absorbed into the leather or canvass.

c. Rubber Gloves. Rubber gloves should be worn when pesticides are being handled. The gloves should be cleaned after use with detergent and water and air-dried upside down.

d. Apron. Made of rubber or plastic, the apron is worn over coveralls to protect against spills and splashing. Clean after each use with detergent and water, and air-dry.

e. Face Shield. A face shield provides full face protection against spills and splashing. The face shield is especially good for people who wear glasses. Clean the shield gently with soap and water after use. Then, air-dry it.

f. Goggles. Goggles can be used instead of full face shield. They may be used with some respirators as a full face respirator. Not all goggles are suitable for pesticide use. Goggles should not have vents on the top as this may allow pesticide into the face in the event of an accident. Clean after use with soap and water and air-dry.

g. Headgear. Wear any soft headgear that can be laundered with the coveralls. If needed, a hard hat that can be cleaned with soap and water can be worn.

h. Earplugs. Earplugs should be fitted by qualified personnel. The plugs should be worn around noisy, hazardous equipment. Reusable earplugs are preferable to disposable earplugs. If the earplugs are reusable, wash them in mild soap and water.

i. Earmuffs. Wear earmuffs around noisy, hazardous equipment. Eternal surfaces can be washed with soap and water. Change the cup seals when they become compressed.

j. Respirators. Follow these guidelines:

(1) Respirators must be fitted to the individual by qualified personnel.

(2) The individual is responsible for the primary maintenance and care of his respirator.

(3) Facial hair may prevent a good facepiece to face-seal. The removal of facial hair may be necessary to obtain a good seal.

(4) Remove canisters/cartridges and clean after use with mild soap and water, and air-dry. Inspect for any damage, broken parts, or wear. Turn in to qualified personnel for parts replacement.

(5) Store in a convenient, clean, and sanitary location which is free of contaminants that might be absorbed by the cartridge or canister.

(6) Replace canisters/cartridges when you: smell organic vapors; experience increased breathing resistance; exceed the canister/cartridge termination date; or after approximately eight hours of work use.

(7) A positive and negative pressure test should be conducted each time a mask is used. This is the only way to ensure it is properly fitted and working correctly.

- Positive pressure test. Close the outlet valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage or air at the seal.

- Negative pressure test. Close off the inlet opening of the canister or cartridges by covering with the palm of the hands or by replacing the seals.

  -- Inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds.

  -- If the facepiece remains in its slightly collapsed condition and no inward leakage is detected, the tightness of the respirator is satisfactory.

(8) All respirators shall be routinely inspected before and after each use; a respirator that is not routinely used but kept ready for emergency use shall be inspected with each use and at least monthly to ensure that it is in satisfactory working condition.

12-3. READ THE LABEL

To determine what protective equipment is required for each application, you must read the label and follow all instructions.

Section II. CRITERIA FOR PEST MANAGEMENT SHOP DESIGN

NOTE: The criteria for the design of pest management facilities is covered extensively in MIL-HDBK- 1028/8A, Design of Pest Management Facilities. This section will give a brief overview of the handbook.

12-4. SITE SELECTION CRITERIA

Site pest management facilities should be a minimum of 200 feet from surface water, existing wells, and cisterns. Site pest management facilities should be downhill from the sensitive areas noted above, or facilities should provide diking where space is limited. Pest management facilities should not be located on or above 100 year flood plains. Consideration must be given to the prevailing wind conditions and the location of populated areas. Facilities shall not be located uphill from potable water sources or continuously occupied structures. Facilities should not be located over aquifers (subsurface potable water supplies) unless the aquifer is adequately protected through containment measures. Runoff from fire-fighting must not reach ponds, lakes, streams, or rivers.

12-5. PESTICIDE HANDLING AREAS

a. Indoor Storage. Pesticides shall be stored in an area sealed or separated from clean areas, with direct access to the exterior. All pesticides stored indoors shall be off the floor so that all labels are visible with lanes to provide effective access and inspection, and stored no more than eight feet high. Pesticides shall be stored in a dry room or building where temperatures above 50 degrees Fahrenheit and below 100 degrees Fahrenheit are maintained. Pesticide storage shall be separated from mixing areas, shower and locker room, offices, or any area where personnel work for prolonged periods. Pesticide concentrates shall not be stored in rooms containing a floor drain of any

type; containment by curbing or sloped floors is required in the pesticide mixing and storage areas. Provide open nonabsorptive shelving for pesticides. Metal cabinets within the storage area are recommended for non-pesticide contaminated equipment storage.

b. Foundations, Floor Slabs, and Floor Finishes. Foundations shall be slab-on-grade with flat (flushed) door sills at interior and exterior doors. Do not install floor drains in the interior pesticide areas. Where pesticides are handled or stored, slope (3/100) floor from sills to the center of interior pesticide areas to collect spilled materials. If a sloped floor is not installed, provide a four inch concrete curb to contain spills and facilitate spill management in the pesticide areas only. The floors in both the storage and mixing areas shall be covered with nonskid epoxy sealant or otherwise made impermeable to absorption.

c. Pesticide Mixing Room. Provide a room with a work area to mix concentrated pesticides into ready-to-use formulations. Mixing rooms shall have electricity and hot and cold water. The work area shall contain a hooded pesticide-resistant sink with closeable drain, a contiguous self-draining drip-proof counter top at least five feet long, sideboards, splash panel on back, and an adjacent shelf for holding measuring devices and concentrates.

d. Shower and Locker Room. Accommodations may be required for male and female employees if the installation requires more than one pest controller. The room serves as a transition area between clean and pesticide handling areas. It contains lockers for street clothing on one side, storage for work clothing (shoes, coveralls, caps, etc.) on the other side, and a third area for protective equipment (respirators). The room shall be accessible to the showers and lockers, toilet, laundry, and cleaning gear areas. Provide a hot water shower for personnel decontamination at the end of the day.

e. Security Fencing and Gates. Provide a climb-resistant chain link fence to prevent unauthorized entry. The fence shall be a minimum of seven feet high, without a top rail. The fence fabric shall be twisted and barbed at the top and bottom.

f. Backflow Prevention. Install a reduced pressure backflow prevention device in accordance with American Water Works Association Standard C506-78, *Backflow Prevention Devices*. Plumbing which provides a source of water for filling pesticide dispersal equipment tanks must be provided with a backflow prevention device so that a water hose attached to a faucet can be used to fill the spray tank.

g. Emergency Eye Wash, Deluge Shower, and Drain. Provide an emergency eye wash and deluge shower with manually operated, delayed-closing valves located adjacent to the mixing counter. Locate eye wash and deluge shower(s) so as to be accessible within 10 seconds from indoor and outdoor mixing areas. An eye wash and deluge shower is essential for emergency washing of individuals accidentally contaminated with pesticides. Reference 40 CFR 165.10(c)(4).

h. Ventilation Mixing and Storage Areas. Provide a separate ventilation system for the mixing and storage areas. System shall provide six air changes per hour (minimum). Design the system to maintain a negative pressure in the mixing and storage areas relative to the clean areas by supplying approximately 95 percent of the air exhausted, with the remainder being from infiltration of ventilation air supplied to the clean areas. Provide a ventilation system control switch with a light to indicate "ON" at the entrance to the pesticide handling areas, and a sign at the switch which reads, "VENTILATION SYSTEM SHOULD OPERATE CONTINUOUSLY. DO NOT ENTER UNLESS VENTILATION SYSTEM HAS OPERATED FOR AT LEAST TEN MINUTES."

i. Signs. Provide identification signs such as "DANGER," "POISON," and "PESTICIDE STORAGE AREA" in appropriate rooms and on buildings and fences to advise personnel of the contents and warn of their hazardous nature. Install a sign to read "NO SMOKING" in the pesticide areas. Install a sign over the sink that reads "DO NOT DISCHARGE PESTICIDES INTO THE SINK." Provide a sign at the entrance

to the toilet that reads "WASH HANDS BEFORE USING TOILET." Provide warning signs on the exterior of the building at each entrance except the utility room. Provide a sign to read "CLOSE DRAIN WHILE HANDLING PESTICIDES ON HARDSTAND." Provide a sign to read "FLAMMABLE PESTICIDES" if a flammable liquid storage cabinet is included in design. Provide building identification information on the outside of the structure visible from 100 feet. Provide a three foot by four foot notice board in the office or hallway near the office for emergency instructions and notices.

Section III. STORAGE AND MIXING PROCEDURES

12-6. STORAGE PROCEDURES

All containers should be stored off the ground with labels plainly visible to permit ready access and inspection. Herbicides and insecticides must be stored separately, maintaining sufficiently safe segregation, with the use of four foot aisles, in order to avoid cross-contamination or adverse reactions. Stored pesticides will be inspected monthly to determine the condition of the containers.

12-7. MIXING PROCEDURES

Review the label before opening the container so that you are familiar with current mixing and loading procedures. Always wear adequate protective clothing and equipment. Put them on before handling or opening a pesticide container. Remember that a respirator and an appropriate form of eye protection should be worn if there is any chance of pesticide inhalation or eye exposure.

NOTE: Never eat, drink, or smoke while handling pesticides.

Section IV. CONTAINMENT OF PESTICIDE SPILLS

12-8. LEGAL REQUIREMENTS

a. Spill Management. Most pesticide spills occur in areas such as loading docks, warehouses, and mixing areas. These are managed on a local basis by the shop, fire department, safety officer, or other base activity. Larger spills not contaminating any waterway or affecting natural resources are handled in essentially the same manner.

b. Water Contamination Spills. In spills contaminating water, the situation is not as simple. The Clean Water Act prohibits the discharge of hazardous substances into or upon the navigable waters of the United States, the adjoining shoreline, or the contiguous zone. Regulations in 40 CFR 116 list chemical substances, including many pesticides, as hazardous, and prohibit their discharge with few exceptions. Violations may result in the levying of monetary penalties.

c. After the Spill. If the quantity of pesticide spilled in water exceeds that listed in 40 CFR 117, that spill must be reported to the appropriate government agency. Pesticides should be included within any activity hazardous materials management and spill contingency plans.

12-9. SPILL PREVENTION

The best means by which a spill can be reduced or prevented is to take precautionary measures such as providing adequate storage facilities for all pesticide chemicals, conducting monthly inspection of these facilities, and ensuring that emergency equipment is on hand for spill cleanup.

Section V. EMERGENCY SPILL PROCEDURES

12-10. SPECIFIC PROCEDURES

When a pesticide spill occurs, specific procedures should be followed for providing first aid, notifying proper authorities, cleaning up, and decontaminating the spill area. Personnel working with pesticides or in areas containing pesticide chemicals should be adequately trained for quick evacuation, proper spill prevention, and emergency procedures.

EMERGENCY SPILL PROCEDURES

- Identification.
- Safety and first aid.
- Care of the injured.
- Site security.
- Containment and control.
- Reporting.
- Cleanup.
- Decontamination.
- Disposal.

12-11. IDENTIFICATION

If possible, determine the pesticide involved in the spill incident. Information such as formulation, percent active ingredient, and manufacturer's name and address should be obtained.

12-12. SAFETY AND FIRST AID

a. Personnel Training. All persons working with pesticides should be well trained in basic first aid and evacuation procedures. When managing any spill, the first concern must be for the health and well being of persons in and around the immediate spill area.

b. Safety Measures. First aid kits should be maintained at pest control shops and storage areas and carried on pest control vehicles. In addition, the telephone numbers of the local medical unit and poison control center should be posted in visible locations and carried by pest control personnel at all times when on the job.

12-13. CARE OF INJURED

Pesticide spill emergencies will differ, but the immediate concern should always be to minimize contamination of personnel. Although the sequence may vary, the following basic procedures should be accomplished as rapidly as possible.

- Quickly assess the spill situation to determine if personnel are involved.
- Eliminate all sources of ignition (e.g., pilot lights, electric motors, gasoline engines) in order to prevent the threat of fire or explosion of flammable vapors (if present).
- If personnel are involved, the rescuer should quickly don necessary protective equipment and remove the victims to a safe location upwind from the spill.
- If the spill occurs in an enclosed area, doors and windows should be opened to enhance ventilation of the area.
- If necessary, remove contaminated clothing from the victim and/or rescuer, then wash affected areas of the body with soap and water.
- Administer additional first aid as necessary, including flushing contaminated eyes with clean water for 15 minutes.
- Obtain medical assistance for injured or contaminated persons. DO NOT leave injured or incapacitated persons alone.
- Always instruct someone to stay with them until proper medical assistance is provided or a physician has been apprised of the situation.

12-14. SITE SECURITY

Secure the spill site from entry by unauthorized personnel by roping off the area and posting warning signs. If necessary, obtain assistance from the activity's police or security unit.

12-15. CONTAINMENT AND CONTROL

Spilled pesticides must be contained at the original site of the spill. The pesticide must be prevented from entering storm drains, wells, water systems, and navigable waterways by the following procedures:

- Don appropriate protective equipment from a spill kit or the pest control shop.
- Prevent further leakage by repositioning the pesticide container.
- Prevent the spill from spreading by trenching or encircling the area with a dike of sand, absorbent material, or, as a last resort, soil or rags.
- Cover the spill. If the spill is liquid, use an absorbent material. If the spill is dry material, use a polyethylene or plastic tarpaulin and secure.

NOTE: Use absorbent materials sparingly as they must also be disposed of as hazardous wastes.

12-16. PESTICIDE SPILL REPORTING

a. Reporting. Not all pesticide spills warrant reporting to the EPA or the Coast Guard. However, spills which involve pesticides equal to or exceeding the designated reportable quantity specified in the EPA's Clean Water Act list of 297 hazardous substances threatening or entering waterways must be reported. All pesticide spills should be reported in accordance with each service's regulations (Air Force, AFR 19-8; Navy OPANV Notice 6240 Ser. 452/322891 10 December 1979; Army AR 200-1) and the activity's spill contingency instruction. Pesticide spills should be reported to the spill coordinator designated in the activity's spill contingency instruction. The coordinator in turn will report the spill to the EPA or the Coast Guard, as required.

b. Notification. The individuals or agencies should be notified, as appropriate, when spills occur. These contacts can also provide information on how to cope with problems which may be encountered in handling pesticide spills. The telephone numbers of contacts should be posted as part of the Pest Control Shop or activity's emergency plan.

12-17. CLEANUP

Adequate cleanup of spilled pesticides is essential in order to remove any health or environmental hazards. When cleaning up pesticide spills, it is advisable NOT TO WORK ALONE and to make sure the area is properly ventilated. Additionally, ensure appropriate protective equipment is used by all personnel.

a. Dry Spills. Dry spills (dusts, wettable powders, granular formulations) should be picked up in the following manner:

- Immediately cover powders, dusts, or granular materials to prevent them from becoming airborne. This can be done by placing a polyethylene or plastic tarpaulin over the spilled material. Weight the ends of the tarp, especially the end facing into the wind.
- Begin cleanup operations by systematically rolling up the tarp while simultaneously sweeping up the spilled pesticide using a broom, shovel, or dust pan. While sweeping, avoid brisk movements in order to keep the dry pesticide from becoming airborne. If the spill is indoors, a cover may not be necessary. When practical, light sprinkling with water may be used instead of a cover.
- Collect the pesticide and place it in heavy-duty plastic bags. Properly secure and label the bags, identifying the pesticide and possible hazards. Set the bags aside for later disposal.

b. Liquid Spills. Liquid spills should be cleaned up by placing an appropriate absorbent material (floor-sweeping compound, gels, sawdust, sand, etc.) over the spilled pesticide. Work the absorbent into close contact with the spilled pesticide. Collect all spent absorbent material and place into a properly labeled leakproof container.

c. Contaminated Soil. Contaminated soil should be removed to a depth of at least three inches below the wet surface line and placed in properly labeled leakproof drums for disposal.

12-18. DECONTAMINATION

a. Decontamination Solutions. Decontamination solutions can be used for decontaminating surfaces and materials where spills of dust, granular, wettable powder, or liquid pesticides have occurred. However, the bulk of the spilled pesticide should be cleaned up or removed prior to applying any decontaminate. After cleaning up the bulk material, apply the appropriate decontamination solution and allow one to six hours' reaction time before using an absorbent material.

b. Pesticide Decomposition. Depending on the location of the spill and the pesticide spilled, chlorine bleach, caustic soda (lye, sodium hydroxide), or lime can be used to effectively decontaminate most spill areas. Many pesticides, especially the organic phosphate pesticides, decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach (sodium hypochlorite).

c. Application of Decontaminants. Dry decontaminants should be spread thinly and evenly over the spill area. Then, using a watering can, lightly sprinkle the area with water to activate the decontaminant. Liquid decontaminants should be premixed and applied with a watering can to the spill area. Decontaminants should be applied in amounts no greater than specified.

d. Decontamination Procedures. The preceding procedures must be repeated until all the spilled pesticide is removed. Clean all equipment used for spill cleanup with detergent and appropriate decontaminants. Collect all spent decontaminants and rinse water and place them in labeled leakproof containers. Clothing and gloves that cannot be decontaminated must be placed in leakproof containers for proper disposal. Depending on the particular surface, the following additional procedures may need to be accomplished as specified.

(1) Nonporous surfaces. Nonporous surfaces should be washed with detergent and water. The appropriate decontamination solution should be thoroughly worked into the surface using a long-handled broom, scrub brush, or other equipment, as needed. Then, the decontamination solution is soaked up using absorbent material which is placed into a labeled, leakproof container for disposal.

(2) Soil. If pesticide containers have leaked or if pesticides have been spilled on a soil surface, all soil should be removed to at least a depth of three inches below the wet surface line and placed in drums for disposal.

(3) Porous materials. Porous materials such as wood may not be adequately decontaminated. If contamination is great enough to warrant, they must be removed and replaced with comparable new materials.

(4) Nonporous objects. Tools, vehicles, equipment, and any contaminated metal or other nonporous objects can be readily decontaminated using detergent and the appropriate decontamination solution. However, smaller quantities of the decontamination solution may be required.

e. Decontaminating Contaminated Equipment. The decontamination solution can be applied to contaminated equipment by soaking the equipment in a pail filled with solution or using a scrub brush. All tools and surfaces must be thoroughly rinsed with sparing amounts of clean water. All rinse water and spent decontamination solution should be collected in drip pans or other suitable containers and transferred to a properly labeled leakproof drum for disposal.

12-19. DISPOSAL

All contaminated materials, including cloth, soil, wood, etc., that cannot be effectively decontaminated as described in this guide must be removed and placed in a sealed leakproof drum. All drums must be properly labeled and disposed of in a hazardous waste disposal facility (incinerator, landfill site, etc.) under current EPA or state permit.

Section VI. SPILL KET CONTENTS AND EQUIPMENT SOURCES

12-20. THE SPILL KIT

Proper handling of pesticide spills requires prior preparation of a spill kit containing directions for use in case a spill incident should occur. The kits should be labeled and designated for use in handling pesticide spills only, and should be strategically placed where spills are most likely to occur. The label should list the contents, and the kit should be sealed to discourage pilferage.

12-21. CONTENTS OF THE SPILL KIT

Spill kits may be assembled by procuring items through the Federal supply system or from commercial sources. Additional suppliers may be obtained by contacting the Engineering Field Division Applied Biologist or command entomologist.

The following is a list of equipment required for shop and vehicle spill kits IAW TIM 15.

Shop Kit

1 55-gallon open-head drum
1 set of instructions
4 pairs of neoprene gloves
2 pairs of unvented goggles
2 respirators and pesticide cartridges
2 aprons (chemical resistant)
2 pairs of rubber boots
2 pairs of 100% cotton coveralls
1 dustpan
1 shop brush
1 square-point "D" handle shovel
1 dozen polyethylene bags w/ties (heavy ply)
1 18" push broom, synthetic fibers
1 gallon liquid detergent
3 gallons household bleach
80 lbs absorbent material
1 bung wrench
1 drum spigot
1 1-3/8" open-end wrench
1 1 drum pump (manual)
30 ft 1/2' polyethylene tubing or
1 25-ft garden hose
1 bung 2 1/2"
1 bung 3/4" blank labels
1 first aid kit

Vehicle Kits

1 instruction sheet
1 5-gallon open-head drum
2 pairs of neoprene gloves
1 pair of unvented goggles
1 respirator and cartridges
1 pair of coveralls
1 dustpan
1 shop brush
10-30 lbs absorbent material
1 pint liquid detergent
1 apron
6 polyethylene bags w/ties (heavy ply)
1 portable eyewash
blank labels
1 first aid kit
1 pr rubber boots

12-22. SOURCES FOR EQUIPMENT AND MATERIALS

Most equipment and materials needed for spill emergency response and for maintaining spill kits can be obtained through the GSA Federal supply system or local manufacturing companies. Major kit components and sources for this equipment are listed below:

a. ABSORBENTS

Sweeping Compound (Sawdust), 100 lbs in fiber drum
NSN 7930-00-633-9849
Source: Serv-Mart and GSA Catalog Floor Sweeping Compound
NSN 7930-00-269-1272
Source: GSA Catalog

Gels
Vermiculite
Clay Absorbent

b. APRON

Disposal polyethylene or spun bonded olefin for protection against damaging chemical and acids.
NSN 8415-00-222-8074
Source: GSA Catalog

c. BUNG WRENCH

Multiple Size
NSN 5120-00-244-4389
Source: GSA Catalog

d. BROOMS

Brush, Dusting, 2-3/4* long bristles
NSN 9720-00-178-8315
Source: GSA Catalog

e. DECONTAMINANT CHEMICALS

Sodium hypochlorite liquid bleach (1 gallon)
NSN 6810-00-598-7316
Source: GSA Catalog

Chlorinated Lime, Technical (24 percent chlorine), 10-oz bottle
NSN 6810-00-825-3298
Source: GSA Catalog

Sodium Hydroxide, Technical (Caustic soda, lye, strongly alkaline material), 100 gal metal drum
NSN 6810-00-270-6581
13-oz metal can
NSN 6816-00-270-8171
Source: GSA Catalog

f. DETERGENT

General liquid (1 gallon)
NSN 7930-00-282-9699
Source: GSA Catalog

g. **Overback Containers for 55-Gallon Drum.** Steel overpack containers (85-gallon drums) are available for transport, storage, or disposal of 55-gallon drums (or smaller containers) containing pesticides or other hazardous materials. The Drum, Hazardous Material, Disposal, NSN 8110-01-101-4055, ($46.76 each) is intended for containment of 55-gallon drums of materials designated for disposal.

- Description. This drum has a solid top without vents or bugs, sealable with a bolt-tightened steel ring. The Drum, Hazardous Material, Recovery, NSN 811001-4056 ($67.91) is for recovery of material in leaking, corroded, or damaged 55-gallon drums. It has a 3/4' vent and 2' bung in the sealable top. Both drums are eligible for land, sea, or air transport. The 55-gallon drum placed in overpacks require cushioning on bottom, top, and sides with absorbent material prior to transport. A suitable material is Insulation, Thermal (Vermiculite, Type II), Bag, 4 cu ft., NSN 5640-00-801-4176. Each overpack drum requires about one bag of absorbent material. The easiest method for recovering useable material from a leaking drum is to transfer the pesticide to a recovery drum with a hand pump, then properly clean and dispose of the empty "leaker."

- Drum preparation. To prepare a drum destined for disposal, turn it on its side (leaking side up if it is a "leaker"), and slide it into the overpack drum. Rotate it to an upright position, add cushioning material, and seal the top. Be sure to properly mark the outside of all overpack containers! For more information, contact the Hazardous Waste Storage section of your servicing Defense Reutilization and Marketing Office (DRMO).

NOTE: For other drum sources, refer to local phone directory.

h. **FIRST AID KITS**

General purpose for easy installation on trucks
NSN 6545-00-526-5312
Source: GSA Catalog

i. **FOOT COVERINGS**

Impervious overshoe boot No. 1500 (sizes regular or large)
Source: Tingley Rubber Co.
South Avenue
South Plainfield, New Jersey 07080

j. **FUNNELS**

General purpose, 1-gallon size
NSN 7240-00-223-4482
Source: GSA Catalog

k. **GLOVES**

Neoprene Coated Canvas No. 908
Source: Good Value Glove Mfg Co.
Seven Front Street
San Francisco, California 94111
(Other suppliers available)

l. **GOGGLES**
Flip Type, sealed
Source: Mine Safety Appliance Co.
518 Eccles Avenue
South San Francisco, CA 94080

m. ***LABELS**
Tag Instructions, Shipping tags for marking hazardous materials (500 labels per box)
SF-410 'POISON'
NSN 7540-00-118-0535

NOTE: Additional labeling may be required. Refer to EPA disposal regulations or the NEPSS Hazardous Waste Disposal Guide.

n. **PLASTIC BAGS**
Waste receptacle Interlocking seal closure, 500 per box 12* x 12*
NSN 8105-00-837-4757
Liners, plastic
Source: GSA Catalog
NSN 8105-00-655-8286
Source: Serv-Mart
Waste receptacle, polyethylene 36' x 54', flat wire tie closure, 005 ml thick
NSN 8105-00-848-9631 Source: GSA Catalog

o. **PUMPS**
Drum pump for 30-55 gallon drums and 5-gallon cans. Stainless steel type *304 for use with chemicals, alkalis, acids, and solvents.
Source: Baldwin Mfg Co.
6130 American Road
Toledo, OH 43612
Phone 419-729-3747

p. **RESPIRATORS AND CARTRIDGES**
Must be approved for use with pesticide chemicals.
Source: AFOSH Std 161-1

q. **SHOVELS**
'D' handle square point
NSN 5120-00-224-9326
Source: GSA Catalog

r. **SCRUB BRUSHES**
Household type
NSN 7920-00-282-2470
Source: GSA Catalog

s. **TARPAULIN**
Tarp, 6' x 10' plastic
NSN 8340-00-582-0521
Source: GSA Catalog

NOTE: Some equipment required for spill cleanup and containment is already available at most shops. Therefore, procurement sources are not listed for every spill item needed.

12-23. DECONTAMINATION SUBSTANCES

Depending on the particular pesticide, chlorine bleach, caustic soda (lye sodium hydroxide) or lime can be used to effectively decontaminate most spills. For other decontamination/degradation options, refer to TIM 15. Many pesticides, especially the organophosphate pesticides, decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach (sodium hypochlorite). Other pesticides cannot be effectively decontaminated and should only be treated with detergent and water to assist in removal. Some examples of common pesticides that can be decontaminated are listed below:

Use Lye or Lime for:	Use Chlorine Bleach for:	Do not use any decontamination Chemicals for these pesticides:
Atrazine	Calcium cyanamide	Alachlor
Propoxur	Calcium Cyanide	Chloramben
Captan	Chlorpyrifos	Chlordane and other
Carbaryl	Fonophos	Chlorinated hydrocarbons
Diazinon	Merphos	Diuron
Temephos	Lethane	2, 4-D
Naled		Maneb
2, 4, 5, - T		Methoxchlor
Malathion		Pentachlorophenol
Acephate		Picloram
Sodium Fluoride		Toxophene
TCA		Trifluralin
Rotenone		
Silvex		
Cyanazine		
Dalapon		
Dichlorvos		
Dimethoate		
EPN		

12-24. A PRACTICAL GUIDE FOR APPLYING DECONTAMINANTS

Percent Active Ingredient	Amount of Decontaminant needed
1-10	Use an amount of decontaminant equal to the quantity of pesticide spilled.
11-79	Use an amount of decontaminant equal to 1.5 times the quantity of pesticide spilled.
80-100	The amount of decontaminant used should be equal to twice the quantity of spilled pesticide.

NOTE: There is a slight potential for creating toxic by-products when using these procedures. In critical situations, samples of affected components (soil, sediment, water, etc.) should be taken and sent to a laboratory for analysis in order to determine if decontamination was successful.

12-25. LYE OR LIME

Pesticides amenable to treatment using lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. These materials can be used in either the dry form or in solution. A 10 percent solution of lye or lime can be made according to the directions in the next paragraph.

a. Mixing Directions. Mix 0.75 pounds of lye or lime in 3.5 quarts of water to make 1 gallon of 10% solution.

CAUTION!

- ☞ Caustic soda (lye) can cause severe eye damage to persons not properly protected. Protect against contact by wearing unventilated goggles.
- ☞ Wear long-sleeved work clothes with coveralls, neoprene gloves, and a chemical resistant apron.
- ☞ Wear an approved respirator.
- ☞ **DO NOT** use lye on aluminum surfaces.

b. Bleach Treatment. Certain pesticides can be degraded by treatment with bleach (sodium hypochlorite).

- ◆ In general, one gallon of household bleach, which contains approximately five percent sodium hypochlorite, should be used per pound or gallon of pesticide spilled.
- ◆ If bleaching powder is used, first mix it with water (one gallon of water per pound of bleach) and add a small amount of liquid detergent.
- ◆ For safety purposes, a preliminary test must be run using small amounts of bleach and the spilled pesticide. The reaction resulting from this test must be observed to make sure the reaction is not too vigorous.
- ◆ **DO NOT** store in close proximity to, or mix chlorine bleach with, ammonia-containing pesticides.
- ◆ Commingling of these materials can cause a violent reaction resulting in fire. Calcium hypochlorite is not recommended as a decontaminating agent because of the fire hazard.

EXERCISES, LESSON 12

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. Personal items such as clothing, food, drinks, and tobacco products should be kept away from where pesticides are stored or handled because

_____

_____

_____

2. The approved footwear for pest controllers is

_____.

3. How should a face shield be cleaned after use?

_____

_____

_____

4. Ear plugs should be worn around _____, hazardous equipment.

5. How do you determine what protective equipment is required for a particular pesticide application? _____

_____

_____

6. The rubber or plastic apron worn over the coveralls should be cleaned after each use with

_____

_____

7. Write T for TRUE or F for FALSE in the space provided for each of the following statements about criteria for pest management shop design.

____ a. Pest management facilities are not to be located uphill from potable water sources.

____ b. All pesticides stored indoors shall be off the floor and stacked no more than eight feet high.

____ c. Floor drains shall be installed in the interior pesticide areas.

____ d. Pesticide mixing rooms must have electricity, hot water, and cold water.

____ e. The security fencing shall have twisted and barbed wire at the top but twisted wire only at the bottom.

8. Contaminated materials from warehouse pesticide spills can be disposed of by:

a. _____

b. _____

c. _____

d. _____

9. What must be done with contaminated materials including cloth, soil, wood, etc. that cannot be decontaminated effectively? _____

_____

_____

_____

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 13	Pesticide Application Techniques.
LESSON ASSIGNMENT	Paragraphs 13-1 through 13-18.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to select procedures to apply pesticides properly IAW TM 5-632 and FM 8-250.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to:

13-1. Identify the factors which must be considered when selecting pesticide formulations and/or equipment for a particular pest management problem.

13-2. Define these pesticide treatment terms:

- Residual treatment.
- Crack and crevice treatment.
- Spot treatment.
- Broadcast treatment.
- Space treatment.

13-3. Identify the pesticide particle size of the following dispersal methods:

- Spraying.
- Misting.
- Aerosolizing.
- Fumigation.

13-4. Identify the characteristics of dusts and granules.

13-5. Define these pest management terms:

- Prevention.
- Suppression.
- Eradication.

13-6. Select appropriate pesticide formulations for specific purposes.

SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 13

PESTICIDE APPLICATION TECHNIQUES

Section I. FACTORS TO CONSIDER WHEN SELECTING EQUIPMENT AND MATERIALS

13-1. INTRODUCTION

As a pest control professional, you are aware of the importance of selecting the correct pesticide and formulation for a particular job.

- Assuming that a chemical treatment is needed, rational decisions are required on the choice, timing, and method of application of the chemical in a way that provides maximum selective toxicity between the target pest and non-target organisms.
- The aim of pesticide application is to distribute the minimum effective amount of active ingredient to the target pest with the minimal contamination of non-target organisms.
- Through the selection of the correct method and technique, your own decisions and judgement will be the key to effective, safe control of the target pest.

13-2. TYPES OF PESTS

Most organisms are not pests. A species may be a pest in some situations and not in others. An organism should not be considered a pest until it is proven to be one. The following are organisms that may become pests that require control efforts:

- Insects: such as roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars.
- Arachnids: such as mites, ticks, and spiders.
- Microbial organisms: such as bacteria, fungi, nematodes, viruses, and mycoplasmas.
- Weeds: any plants growing where they are not wanted.
- Mollusks: such as snails, slugs, and shipworms.
- Vertebrates: such as rats, mice, other rodents, birds, fish, and snakes.

ORGANISMS - SOMETIMES PESTS

- Insects.
- Insect-like organisms.
- Microbial organisms.
- Weeds.
- Mollusks.
- Vertebrates.

13-3. TYPE OF AREA/SURFACE

Sometimes pesticides must be deliberately applied to a sensitive area to control a pest. These applications should be performed by personnel who are well trained about how to avoid causing nontarget, personal, or environmental injury in such areas. The following are examples of sensitive areas:

a. Porous surface, runoff surface. At two extremes, both a porous surface and a runoff surface are sensitive areas.

b. Sensitive Area Indoors.

- Areas where people, especially children, or the sick, live, work, or are cared for.
- Areas where food or feed is processed, prepared, stored, or served.
- Areas where domestic or confined animals live, eat, or are otherwise cared for.

- Areas where ornamental or other sensitive plantings are grown or maintained.

c. Sensitive area outdoors.

- Area where ground water is near the surface or easily accessed (wells, sinkhole, porous soil, etc.).
- Areas in or near surface water.
- Areas near schools, playgrounds, hospitals, and other institutions.
- Areas near the habitats of endangered species.
- Areas near apiaries (honeybee sites), wildlife refuges, or parks.
- Areas near ornamental gardens, food or feed crops, or other sensitive plantings.

d. Considerations.

- Consider whether there are conditions in the treatment site environment that may cause the pesticide to move off site
- Consider whether you need to change any factors to reduce the risk of environmental contamination.

13-4. CONDITION/SIZE OF APPLICATION SITE

Condition and size of the application site will influence the type/capacity of the nozzle and size of reservoir.

13-5. AVAILABILITY OF EQUIPMENT AND MATERIALS

Choices to be made inlcude the following:

- Hand operated vs. motor driven.
- Hand carried vs. powered vehicular.
- Ground vs. aerial.

13-6. TYPE OF FORMULATIONS AVAILABLE

a. Ultra Low Volume (ULV)/Ultra Low Dose (ULD). These are special purpose formulations used mostly in the treatment of adult flying insects. These formulation are concentrates that may approach 100 percent active ingredient and are designed to be used as is or diluted with only small quantities of specified solvents. These formulations are applied as very small droplets at relatively low rates.

FORMULATION TYPES

- Ultra low volume/ultra low dose.
- Solutions, emulsions, flowables.
- Dust, granule.
- Baits and pastes.

(1) Advantages of ULV/ULD.

- Relatively easy to handle, transport, and store.
- Require little agitation.
- Not abrasive to equipment.
- No plugging of screens and nozzles.
- Little visible residue.

(2) Disadvantages of ULV/ULD.

- High drift hazard.
- Specialized equipment required.
- Easily absorbed through skin of humans and animals.
- Solvents may cause deterioration to parts and surfaces made from rubber or plastic.

b. Emulsions, Solutions, and Flowables.

(1) Emulsions. Emulsifiable concentration (EC) formulations usually contain liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form an emulsion. An EC usually contains 25 to 75 percent (two to eight pounds) active ingredient per gallon and is one of the most versatile formulations. These formulations are used against agricultural, ornamental and turf, forestry, structural, food processing, livestock, and public health pests.

- Advantages of emulsions.
  - -- Adaptable to many types of application equipment from small, portable sprayers to hydraulic sprayers mist blowers, low-volume ground sprayers, and low-volume aircraft sprayers.
  - -- Relatively easy to handle, transport, and store.
  - -- Will not settle out or separate when equipment is running.
  - -- Nonabrasive and do not plug screens or nozzles.
  - -- Little visible residue.
- Disadvantages of emulsions.
  - -- Flammable.
  - -- High concentration makes it easy to overdose or underdose through mixing or calibration errors.
  - -- Easily absorbed through skin of humans and animals.
  - -- May be corrosive and phytotoxic.

(2) Solutions. Solutions are pesticide active ingredients dissolved in a liquid solvent such as water or a petroleum-based solvent or specially refined oil that when mixed do not settle out or separate. The active ingredients vary, depending on the solvent and type of application involved.

- Advantages of solutions.
  - -- No agitation necessary.
  - -- Can be used in structural and institutional pest control; some household pest control; space sprays; mosquito control; and shade tree pest control.
- Disadvantages of solutions.
  - -- Limited number of formulations of this type available.

(3) Flowable liquids. Flowables are formulations with active ingredients that are insoluble in water. The active ingredients are finely ground and added to a liquid along with special chemicals to keep the ingredients in suspension.

NOTE: Flowables are mixed with water for application, are similar to EC or wettable powder formulations, and are used in the same types of pest control operations as ECs.

- Advantages of flowables.
  - -- Seldom clog nozzles.
  - -- Easy to handle and apply.
- Disadvantages of flowables.
  - -- Require moderate agitation.
  - -- May leave a visible residue.

c. Dusts, Granules.

(1) Dust. Dust formulations are ready to use active ingredients, usually .5 percent to 10 percent, plus an inert carrier like talc, chalk, clay, nut hulls, or volcanic ash. Dusts are always used dry in their applications in agricultural structures, cracks, crevices, and spot treatments.

- Advantages of dust.
  - -- Ready to use, no mixing, effective in hard to reach indoor areas, and require simple application.
- Disadvantages of dust.
  - -- Drifts easily to non target areas, will not stick to surfaces as well as liquids, difficult to get an even application of particles on surfaces.

(2) Granules. Granule formulations are larger and heavier than dusts. The active ingredients range from 1 to 15 percent, and the inert ingredient is either coated or impregnated with the active ingredient. Grannules are commonly used to apply chemicals to the soil to control weeds, nematodes, and insects living in the soil.

d. Baits and Pastes. Bait formulations are made of a low concentration of active ingredient, usually less than five percent, mixed with food or another attractive substance. Baits are used inside buildings to control ants, roaches, flies, insects, and rodents. Outdoors they are used to control snails, slugs, and some insects.

- Advantages of baits and pastes.
  - -- Ready to use.
  - -- Good for attracting pests.
  - -- Control pests coming in and out of an area.
  - -- Specific for target pest.
- Disadvantages of baits and pastes. If baits are not properly contained (e.g., bait boxes), they may be hazardous to:
  - -- Non-target wildlife.
  - -- Children.
  - -- May become a food source for pest after pesticide becomes ineffective if not removed.
  - -- Dead pests may cause odor problems.

Section II. PESTICIDE APPLICATION TECHNIQUES

13-7. RESIDUAL TREATMENT

Residual treatment may be defined as the application of a long-lasting pesticide to surfaces where pests may feed, rest, or merely crawl. The target effect of the application results with the residual treatment taking a preventive and corrective control of the target pest. Residual is a relative term describing the efficacy of a pesticide over time. The residual effect may last days, weeks, or years, depending on the formulation and active ingredients.

APPLICATION TECHNIQUES

- ☼ Residual treatment.
  - o Crack and crevice.
  - o Spot.
  - o Broadcast.
- ☼ Space treatment.

a. Advantages of Residual Treatment.

- Target pest doesn't have to be present.
- Pesticide remains active for extended period, giving effective control.
- Treatment is not required as often, saving time and money.

- Residuals may be applied as solutions, emulsions, technical grade pesticides, suspensions, dusts, or granule formulations.

b. Disadvantages of Residual Treatment.

- Hazardous to non-target organisms.
- Slow acting--up to 10 days for desired results.

c. Categories of Residual Treatment.

- Crack and crevice treatment refers to pesticides applied only to cracks and crevices where pests may hide or through which they enter a building.
- Spot treatment is pesticide applied to areas where pests rest or feed. The EPA definition is noncontinuous spots of two square feet or less. Application is usually to the point of runoff, excluding treatment of an entire facility to manage cockroaches, termites, ants, and wasps.
- Broadcast treatment is spreading pesticide--usually dusts, granules, or liquids--over a broad area, treating the entire area where pests live. A ground dispersal-boom sprayer or bean pump may be used. Aerial dispersal is low volume or high volume broadcasting of granules.
- Injection treatment, the application of pesticide beneath the soil or water surface, is a common method for termites and some soil pests. It can be spot treatment or cover larger areas.

13-8. SPACE TREATMENT

Space treatment is the application of pesticide to the air space through which the pest travels--applied in quantity of pesticide per cubic foot or volume. The pesticides used have little or no residual (usually less than one day).

a. Advantages of Space Treatment.

- Applied quickly.
- Quick kill without residual.
- Good for use in restaurants and food storage facilities.
- Useful where pests cannot be seen.
- Good for control of flying insects.

b. Disadvantages of Space Treatment.

- High toxicity due to concentrate.
- Hazard to non-target organisms.
- Fog drift.
- Can cause paint damage.
- Fire hazard.

Section III. PESTICIDE DISPERSAL METHODS

13-9. SPRAYING

Spraying is generally defined as the application of liquid pesticide formulation. Recent developments define spraying as the application of liquids atomized into droplets 100 microns in diameter or greater.

a. Size.

- Fine spray: 100 to 400 microns in diameter.
- Coarse spray: 400 microns or larger in diameter.

b. Characteristics of Spraying.

- Rapid "fall out" of large droplet size.

- Provides a good residual.
- Used in low concentrations and applied under low pressure.

c. Uses of Spraying. Sprays are applied either to pest body surfaces or surfaces that the pest will come in contact with at some later time.

PARTICLE SIZE of PESTICIDES

- Spraying = fine spray - 100 - 400 microns in diameter. course spray - 400 microns or larger in diameter.
- Misting = 50 - 100 microns in diameter.
- Aerosolizing = 80 percent of particles less than 30 microns in diameter. No particles larger than 50 microns in diameter. ULV/ULD particles 5 to 30 microns in diameter.
- Fumigation = gaseous molecules.

13-10. MISTING

Misting is defined as dispersed liquid formulations that are intermediate in size.

a. Size. Size can be 50 to 100 microns in diameter.

b. Characteristics of Misting.

- Heavy enough to settle out, but remain airborne longer than sprays.
- Better penetration of foliage than sprays.
- Concentration higher than sprays.
- Fair residual.

c. Uses of Misting.

- Effective for outside residual and space treatment.
- For mosquito larviciding in areas accessible to wheeled vehicles and for large scale residual spraying of vegetation.
- Can be used indoors, with caution.
- Can be used under wider range of weather conditions than aerosols.

13-11. AEROSOLIZING (INCLUDING FOGGING)

Aerosolizing is the application of liquid formulations with droplets smaller than misting.

- Thermal aerosolizing fogging is atomizing an insecticide solution with hot gases or super heated steam. This type of fogging has the distinct appearance of dense, white fog.
- Cold aerosolizing (fogging) is the combining of pesticide with a liquid which boils at low temperatures. The mixture is discharged by its vapor pressure through a small orifice.
- Mechanical shearing (ULV/ULD) is the atomizing of pesticide by applying it at high pressure through small nozzles, disks, or propellers. In the case of aerial applications, atomization may also be assisted by air speed.

a. Size.

- Eighty percent of particles are less than 30 microns in diameter, and no particles are larger than 50 microns.
- ULV/ULD particles range from 5 to 30 microns in size.

b. Characteristics of Aerosolizing.

- Virtually no residual; aerosol remains airborne longer.

- Excellent penetration.
- Influenced by weather conditions.
- Use ultra low volume outdoors. Air temperature must be between 40° and 85° F, higher than the ground temperature, with a wind speed of less than 10 mph.
- Use ultra low dosage indoors.
- Use in applying concentrated pesticides.

c. Uses of Aerosolizing.

- Use ultra low dosage indoors for cockroaches, flies, fleas, stored product pests.
- Use in airtight spaces to prevent dissipation.
- Use in stored subsistence, rodent burrows, wood structures for wood destroying pests.
- Soil fumigation for nematodes, etc.

13-12. FUMIGATION

Fumigation is the application of pesticide in its gaseous state. Specialized application equipment is usually not needed, but special personal protective equipment may be required. Seal treated areas with an airtight, impervious material such as polyethylene plastic.

a. Size. Gaseous molecules.

b. Characteristics of Fumigation.

- No residual after the treatment period.
- Lethal to all exposed organisms.

c. Uses of Fumigation.

- For stored subsistence, fumigation is the only pesticide treatment that can be used on foods intended for human consumption.
- Rodent burrows.
- Wooden structures for wood destroying organisms.
- Soil fumigation for nematodes.

13-13. DUSTING

Dusting is the application of pesticide in solid particles extending in size within the same range as liquids.

a. Size. 400 microns.

b. Characteristics of Dusting.

- Good residual, remains airborne a long time with good penetration.
- Biggest problem is drift and nonadherence to surfaces.
- Not readily absorbed.
- Less hazardous to domestic plants and animals.
- Slower acting than liquid.

c. Uses of Dusting.

- Good control of crawling insects, particularly those confined to limited areas such as fleas and lice.
- Often used in rodent ectoparasite control.
- Used for cockroach and ant control in places where liquid is not practical; for example, fuse boxes, and electrical switch boxes.

13-14. GRANULES AND PELLETS

Inert granules or pellets are impregnated with pesticide (may be silica sand or synthetic substance).

a. Size. Larger than 400 microns.

b. Characteristics of Granules and Pellets.

- Excellent penetration through area of dense trees and plants.
- Little or no drift.
- Delayed residual release.

c. Uses of Granules and Pellets.

- Aquatic habitats for mosquito larvae control (dispersed by air or ground equipment).
- Good for areas that are inaccessible to wheeled vehicles (aerial spray) and areas where repeated treatment is not desired or practical.

13-15. MISCELLANEOUS METHODS

Included are the following:

- Paints-wood preservative, orchard pesticides such as Diazinon White Wash, Kill Master (Dursban^{R} microencapsulated in resin).
- Drag bar (weed killer).
- Baits and attractants; for example, sticky baits, roach hotels.

Section IV. NOZZLE SELECTION AND CALIBRATION

13-16. TYPES OF NOZZLES AND THEIR USES

Three types of nozzles are common: the solid stream nozzle; the hollow cone nozzle; and the full or solid cone nozzle.

- Solid stream is appropriate for crack and crevice treatment.
- Use hollow cone to apply pesticide to irregular surfaces such as foliage, edges of body of water with emergent vegetation, for mosquito larviciding, both broadcast and spot treatment.
- Full or solid cone is for irregular surfaces where high volume is necessary, surfaces such as foliage, adobe walls, etc.

13-17. NOZZLE NUMBERS FOR FLAT FAN (USUALLY 6 DIGIT)

- First two numbers = spray tip angle.
- Last four numbers = nozzle capacity in gallons per minute (GPM) at 40 pounds per square inch (PSI). The decimal is placed after the 3rd digit automatically.

NOTE: #730616 = 73 spray tip angle;
0616 = 0.616 GPM at 40 PSI

13-18. CALIBRATION

Accurate calibration is essential to ensure that nozzles are in good shape and meet manufacturer's specification. Runn water through nozzle at 40 psi to ensure the output is consistent with rated nozzle capacity.

NOTE: DO NOT use metal objects to clean nozzles!

Section V. THREE PEST CONTROL GOALS

Prevention. When the pest's presence or abundance can be predicted in advance, and finally kept from becoming a problem.

> **NOTE: Control a pest only when it is causing or is expected to cause more harm than is reasonable to accept.**

Suppression. A common goal with intent to reduce the pest population to a level where the harm it is causing is acceptable.

> **NOTE: Suppression and prevention often are joint goals because the right combination of control measures can often suppress the pests already present and prevent them from building up again to a level where they are causing unacceptable harm.**

Eradication. Total elimination of a pest population.
Eradication is a rare goal in outdoor pest situations. Usually this goal is attempted when a foreign pest has been accidentally introduced but is not yet established in an area. Eradication is commonly used to destroy pests of stored subsistence and wood destroying pests in structures.

EXERCISES, LESSON 13

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List three factors to consider when you are selecting pesticide formulations and/or equipment for a particular pest management program.

   a. _____

   b. _____

   c. _____

2. What is residual treatment? _____

   _____

   _____

3. A pesticide treatment applied to a noncontinuous area of two square feet or less is termed _____.

4. Broadcast treatment is pesticide applied by

   _____

   _____

5. Granules and pellets impregnated with pesticide are _____.
   (size)

6. Fill in the blanks with one of the three pest control goal: prevention, suppression, and eradication.

   a. The goal attempted when a foreign pest has accidentally been introduced but is not yet established in an area is _____.

   b. _____ is a goal whose intent is to reduce the pest population to a level where the harm it is causing is acceptable.

   c. Use _____ techniques when the pest's presence or abundance can be predicted in advance.

7. ULV applications should be done when the air temperature is between ___ and ___, air temperature is ___ than ground temperature, and wind is less than ___ miles per hour.

8. List the two biggest problems of the dusting as a pesticide dispersal method.

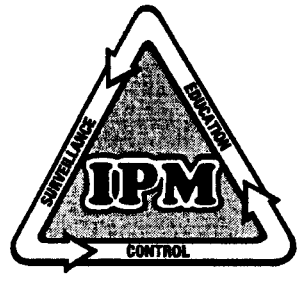
   a. _____

   b. _____

9. _____ are appropriate when penetration through trees and dense vegetation is required.

10. When applying pesticides to irregular surfaces, use a _____ nozzle.

END OF LESSON EXERCISES



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	LESSON ASSIGNMENT
LESSON 14	Pesticide Application Equipment.
LESSON ASSIGNMENT	Paragraphs 14-1 through 14-22.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to select the correct application equipment to perform a pest management job IAW TM 5-269.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 14-1. Match a pesticide application job to the appropriate pesticide dispersal equipment. 14-2. Select the appropriate piece of pesticide application equipment to use in a particular environmental condition. 14-3. Identify the techniques to reduce drift to nontarget areas when applying pesticides.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 14

PESTICIDE APPLICATION EQUIPMENT

Section I. METHODS OF APPLICATION

14-1. INTRODUCTION

Now that you have identified the pest, selected the proper pesticide, safely transported and stored the chemical, you are ready to have the chemical go to work for you. This lesson covers how to select the proper equipment and how to precisely apply the pesticide. Applying chemicals properly saves money and protects the environment.

a. Match Pesticide to the Job. Pesticides may be applied as sprays, dusts, granules, gases (vapors), fogs, baits, rubs, or dips.

- The vast array of available equipment must be matched to the pesticide material as well as the size and type of job.
- To make an effective, safe, and efficient application, the equipment must be properly selected, operated, calibrated, and maintained.

b. Choose Appropriate Equipment. Choosing appropriate application equipment and operating and maintaining it properly is as important to effective pest management as selecting the pesticide.

- The substantial investment involved requires that the choice be based on a thorough familiarity with all alternatives, including the most recent developments in application technology.

- Many problems of current concern (e.g., drift, nonuniform coverage, failure of a pesticide to effectively reach the target organism, selective control) are at least partially solvable through newly developed application techniques and equipment.

CURRENT PROBLEMS OF PESTICIDE APPLICATION

- ☼ Drift.
- ☼ Nonuniform coverage.
- ☼ Failure of a pesticide to effectively reach the target audience.

- When you choose application equipment, be sure that it is well adapted for your purposes, cost effective, has maximum efficiency, and will apply materials in an environmentally sound manner.

14-2. METHODS OF APPLICATION

a. Review--Pesticide Application Methods. Before discussing specific types of application equipment, we need to briefly review the various methods to apply pesticides.

- Factors in choice of method. The particular method of application chosen depends on the nature and habits of the target pest, the plant, the pesticide, available application equipment, and the relative cost and efficiency of alternative methods.

- Choice--more than one method. The application method is often predetermined by one or more of these factors, although there is frequently a choice between two or more methods.

- The principal objective. Always bear in mind that your principal objective is to effectively bring the pesticide into contact with the target organism(s).

b. Common Methods. Common methods of applying pesticides are listed in the box which follows.

APPLICATION METHODS

- ☼ Broadcast applications.
- ☼ Direct-spray applications.
- ☼ Spot treatments.
- ☼ Injection.
- ☼ Crack and crevice treatments.

Section II. APPLICATION EQUIPMENT

14-3. TYPES OF SPRAYERS

We use a variety of equipment in an attempt to place the pesticide on the target in a uniform pattern, and offer safety to nontarget plants, animals and people. Common equipment is described here.

a. Hand Sprayers. Hand sprayers are for applying pesticides in structures such as dining facilities and can be used for small jobs such as spot treatments.

- You can use them in restricted areas where a power unit would not work.

- A high quality hand sprayer should have a pressure gauge.

b. Low-Pressure Field Sprayers. These sprayers are designed to deliver low to moderate volume at 15 to 50 psi.

- Most of them are used for treating field and forage crops, pastures, fence rows, and structures.
- They also may be used to apply fertilizer-pesticide mixtures and may be mounted on tractors, trailers, trucks, and aircraft.

c. High-Pressure (or Hydraulic) Sprayers. This type of sprayer delivers large volumes at high pressure, up to 1,000 psi, and is often used to spray fruits, vegetables, trees, landscape plants, and livestock.

- When fitted with the correct pressure regulators, high-pressure sprayers can be used at low pressures.
- Applications usually are made at high rates (usually 50 or more gallons per acre).
- They have good spray coverage and penetration but may drift easily due to the high pressure.

d. Air Blast Sprayers. These units use a high-speed, fan-driven air stream to break the nozzle output into fine drops which move with the airstream to the target. The air is directed to either one or both sides as the sprayer moves forward.

- These sprayers are used to apply pesticides to landscape plants, fruits and vegetables, and for insecticide applications.
- Most air blast sprayers can be adapted to apply either high or low volumes of spray.
- Since air speeds exceed 100 mph, drift is a major concern; it is hard to confine the spray to a limited target area.

e. Ultra Low Volume Sprayers. These sprayers distribute a very small amount of concentrated insecticide solution over a relatively large outside area, using aerial equipment and ground sprayers.

- Ultra low volume sprayers are used for the control of disease vector and nuisance pest control for routine and contingency military operations.

f. Ultra Low Dosage Sprayers. These sprayers distribute a very small amount of concentrated insecticide solution over a relatively large enclosed area.

- Ultra low dosage sprayers are used in the pest control industry to apply pesticides, disinfectants, deodorants, and germicides in enclosed spaces of warehouses, hospitals, and residences.

g. Motorized Backpack Sprayers. These small, 2-cycle, engine-driven blowers are used for dispersing liquid and solid formulations over broad areas or areas inaccessible to wheeled vehicles.

h. Aerial Pesticide Dispersal Units. Multi-capable units are used for aerial dispersal of pesticides over large areas. The units are capable of dispersing ultra low volume formulations, low volume, and solid formulations (pellets and granules).

SPRAYER TYPES

- ☼ Hand sprayers.
- ☼ Low-pressure field sprayers.
- ☼ High-pressure sprayers.
- ☼ Air blast sprayers.
- ☼ Ultra-low volume sprayers.
- ☼ Ultra-low dosage sprayers.
- ☼ Backpack sprayers.
- ☼ Pesticide dispersal units.

14-4. ROPE WICK APPLICATORS

The rope wick applicator uses a long horizontal tube filled with a liquid systemic or contact herbicide.

- A wetting pad or a wick is then attached to the outside. As the unit moves through the field, the herbicide is applied to only the weeds that brush against it.

- It is effective for eliminating weeds growing taller than the crop. Little or no pesticide is wasted.

14-5. GRANULAR APPLICATORS AND DUSTERS

a. Granular Applicators. These include: (1) hand-carried knapsack and spinning disk types for broadcast coverage, (2) mounted equipment for applying bands over the row in row crops and vegetables, (3) mounted or tractor drawn machines for broadcast coverage, and (4) PDU for broadcast coverage for large areas. Granular applicators minimize pesticide drift and eliminate mixing of chemicals, but high cost and limited use are major concerns.

b. Dusters. Types of dusters include hand carried squeeze bulbs, bellows, and a fan powered by a hand crank.

- Power dusters use a powered fan or blower to propel the dust to the target.

- They range from knapsack or backpack types to those mounted on or pulled by tractors. Their capacity in area treated per hour compares favorably with sprayers.

- Drift is a major concern when using dusts outside.

14-6. FUMIGANT APPLICATORS

There are three types of fumigant applicators: smokes, low pressure applicators, and high pressure applicators.

a. Smokes. This simple method of applying pesticides is used in greenhouses and enclosed rooms. Containers are ignited, and the pesticide is carried in the smoke. Place warning signs on all doors when fumigating.

b. Low Pressure. The low-pressure fumigators are gravity or pump fed units.

c. High Pressure. Most high pressure units are pressure generated by the fumigant or a compressed gas to force the fumigant into the soil or space being fumigated.

NOTE: Some fumigants like hydrogen phosphide require no application equipment.

14-7. AEROSOL GENERATORS AND FOGGERS

Aerosol generators work by using atomizing nozzles, spinning disks, or small nozzles at high pressure. Fogs are usually generated by thermal generators using heated surfaces.

- Truck- and trailer-mounted machines are for outdoor use. Most hand-operated or permanently mounted automatic machines are for indoor use.

- Be sure that the pesticides are registered for use in generators and foggers.

Section III. BASIC COMPONENTS OF SPRAYERS

14-8. FOUR BASIC COMPONENTS

Like a hydraulic system, a sprayer has four basic components:

- Tank--to hold fluid.
- Pump--to move the fluid.
- Valving--to deliver the fluid.
- Output--a cylinder for hydraulics, a nozzle for a sprayer.

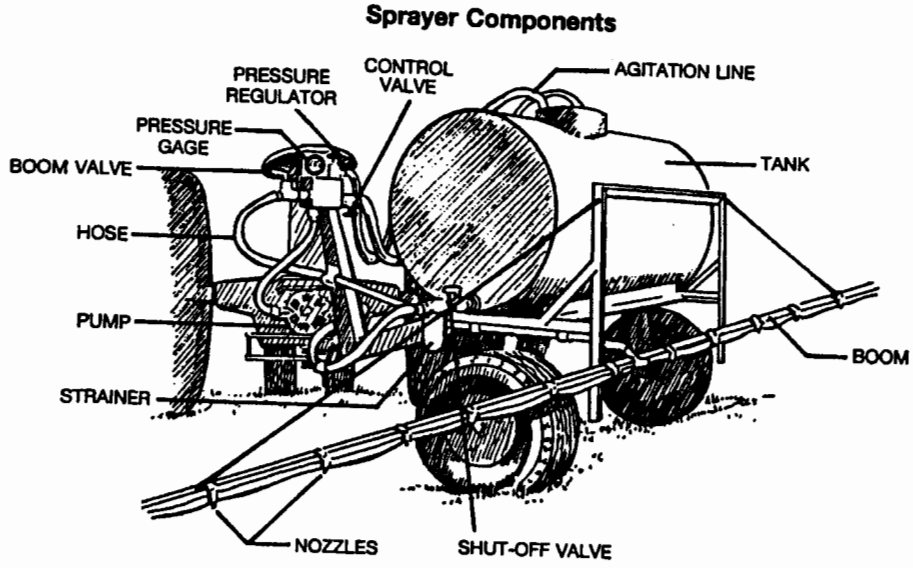

Figure 14-1. Typical motor driven boom sprayer.

14-9. TANKS

a. Construction. Tanks should have large openings for easy filling and cleaning. They should allow for straining during filling and have mechanical or hydraulic agitation.

- Square tanks and ones with flat bottoms make agitation and cleaning more difficult.
- The tank should be made of corrosion resistant material such as stainless steel or glass reinforced plastic.
- If made of mild steel, it should have a protective plastic lining or coating. Tanks should have a drain at the lowest part, and outlets should be sized to the pump capacity.
- If you use dual tanks, make sure the plumbing allows for agitation and adequate withdrawal rates in both tanks.
- The operator should be able to see the liquid level of the tank gauge.

b. Maintenance.

- Flush out the tank, pump, lines, and nozzles after each day's use and each separate pesticide use.
- If switching to another pesticide where contamination must be prevented, wash out with detergent and water two or three times and then flush with water.
- Phenoxy herbicides such as 2,4-D are difficult to remove.
- After using them, follow the special cleaning procedures noted on the pesticide label.
- Keep the tank clean inside and out. Tighten or repair all leaky tank seals and fittings.
- Make sure sight gauges can be read.

14-10. PUMPS

The pump is the heart of the spraying system and must deliver adequate flow at needed pressure.

- Pumps should resist corrosion and abrasion.
- The three most common pumps are centrifugal, roller, and piston.

14-11. CONTROL VALVES

The control valve is a quick-acting, positive shut-off.

- Control valves should be large enough so as not to restrict flow and should be easy to reach.
- On-off action should be quick, positive, and capable of cuting off all flow or flow to any section of the spraying system.
- There may be a central control valve and also individual boom valves.
- The relief valve is adjustable, controls line pressure, and returns excess spray solution to the spray tank.

14-12. NOZZLES

Nozzles are the most critical part of the sprayer. The nozzle controls the rate and pattern of distribution. Specifically, the rate and pattern of distribution depend on:

- The nozzle design or type.
- Its operating pressure.
- The size of the opening.
- Its discharge angle.
- Its distance from the target.

14-13. BASIC NOZZLE TYPES

There are seven basic nozzle types, all other patterns are variations of these seven:

a. Solid Stream. This type is used in hand guns to spray a distant target. It is also used in a nozzle body to apply pesticides in a narrow band or inject them into the soil. The solid stream nozzle combined with a disc is used in air blast sprayers.

b. Flat Fan. There are three types of flat fan nozzles:

(1) Regular flat fan. The regular flat fan nozzle makes a narrow oval pattern with lighter edges. It is used for broadcast spraying. This pattern is designed to be used on a boom and to be overlapped 30 to 50 percent for even distribution.

(2) Even flat fan. The even flat fan nozzle makes a uniform pattern across its width. It is used for band spraying and for treating walls and other surfaces.

(3) Flooding nozzle. The flooding nozzle makes a wide-angle flat spray pattern. It works at lower pressures than the other flat fan nozzles. Its pattern is fairly uniform across its width. It is used for broadcast spraying.

c. Hollow Cone. There are two types of hollow cone nozzles: the core and disc, and the whirl chamber. The hollow cone pattern is circular with tapered edges and little or no spray in the center. It is used for spraying foliage and produces a fine droplet size.

d. Solid Cone. A circular pattern is produced by the solid cone nozzle. The spray is well distributed throughout the pattern with larger droplet size than the hollow cone produces.

e. Atomizing. The atomizing nozzle makes a fine mist. It is used indoors in the greenhouse industry and in livestock buildings.

f. Broadcast. The broadcast nozzle forms a wide flat fan pattern. Used on boomless sprayers, it extends the effective swath width when attached to the end of the boom.

g. Rotary. This nozzle type, also called controlled droplet applicator, forms droplets of uniform size.

- Liquid enters the center of the spinning cup, and like the centrifugal pump, it forces the liquid up grooves on the inside of the cup.
- When droplets are heavy enough, they fly off the edge of the spinning cup. Varying the speed of the cup produces droplets of different sizes.
- Fast speed produces small droplets, slow speed produces large droplets.

THE SEVEN
BASIC NOZZLE TYPES

- ☼ Solid stream.
- ☼ Flat fan.
- ☼ Hollow cone.
- ☼ Solid cone.
- ☼ Atomizing.
- ☼ Broadcast.
- ☼ Rotary.

14-14. OPERATION AND MAINTENANCE

Always read and follow the operator's manuals for your spray equipment. Check for leaks in lines, valves, seals, and in the tank after filling with water and during calibration.

a. Nozzle Clogging. Be alert for nozzle clogging and changes in nozzle patterns. If nozzles clog or other trouble occurs in the field, be careful not to contaminate yourself while correcting the problem. Wear protective clothing while making repairs.

b. Storage. Store sprayers correctly after use. Clean all parts thoroughly. Drain the pump and plug its openings or fill the pump with light oil or antifreeze. Follow the manufacturer's guide for storage.

Section IV. PESTICIDE DRIFT

14-15. AVOIDING DRIFT

a. Pesticide Drift Identified. Pesticide drift has been identified by both the chemical industry and the Environmental Protection Agency as one of the principal concerns in outdoor pesticide application. Where significant drift occurs, it can damage sensitive plants, pose health hazards, contaminate soil and water in adjacent areas, and cause considerable friction among neighbors. Although it is impossible to eliminate drift entirely, it can be reduced to acceptable levels.

b. Drift Defined. Drift can be defined simply as the movement of pesticides through the air to nontarget area and may occur either as a solid, as liquid particles, or as vapors.

14-16. DRIFT OCCURRENCE

a. Particle Drift. At the time of application, small spray droplets may be carried by air movement from the application site to other areas. The distance a particle of pesticide spray can drift is determined by one or more factors:

- The speed of an existing crosswind.
- The distance from the spray nozzle to the ground.
- The size of the particle itself.

Normally, only areas in the immediate vicinity of the application site are a affected by particle drift.

b. Vapor Drift. Vapor drift is the movement of pesticide from the target area as a vapor and results from the tendency of chemicals to volatilize. Where vapor drift occurs, it may affect sensitive areas up to one mile or more from the application site.

14-17. AERIAL APPLICATIONS AND DRIFT

Aerial applications are particularly susceptible to drift since the materials are released from greater heights and a greater percentage of smaller droplets are formed than with ground equipment. Factors that influence drift include particle size, specific gravity, evaporation rate, height of release, air movements, weather conditions, and the aerodynamic forces created by the aircraft.

14-18. OIL-SPRAY DROPLETS AND DRIFT

Oil-spray droplets tend to drift farther than water-spray droplets because they are usually lighter and smaller and thus remain airborne for a longer period. Using the same hydraulic nozzles and the same spraying pressure, smaller droplet sizes are produced with oils than with water. In addition, the rate of evaporation of water-base sprays is higher than that of oil-base sprays for equal-size droplets unless anti-evaporant materials are added to the formulation.

14-19. IMPACT OF WEATHER CONDITIONS

a. The Effect. Weather conditions directly affect the direction, amount, and distance of drift.

---- CAUTION ----

Avoid applications when the wind is blowing toward susceptible plants or sensitive areas or when wind speed is in excess of limits stated on the product label.

You may have to cease operations during unfavorable weather conditions. Consult weather forecasts whenever possible. One danger is that unpredictable changes in air movement may occur and carry the drift in an unexpected direction.

b. The Difference With Time of Day. During early morning and late evening, the difference in the air temperature at ground level and at some distance above the ground is considerably less than during the middle of the day.

- As the ground warms up, the air temperature near the ground becomes significantly higher than the air above it.
- This warmer air rises and may set up convection and thermal air currents which lift small particles.
- These suspended particles may be carried some distance before they settle out.
- For this reason, and because wind speeds are frequently lower, it is often better to apply pesticides either in the early morning or in the evening.

14-20. DRIFT CONTROL

The following measures help prevent or lessen drift:

- Use the lowest reasonable pressure.
- Set the boom only as high as is needed for good coverage.
- Leave an untreated border around the field.
- Angle nozzles of ground sprayers slightly forward toward the ground in the direction of travel.
- Where practical, use a nozzle type which produces the largest droplets at a given rate and pressure.
- Use nozzles with the largest openings possible for the rate and pressure required.
- Use nonvolatile or low-volatile formulations whenever possible.
- Spray when wind speed is low.
- Do not spray aerially during a temperature inversion (when

ground air is two to five degrees cooler than the air above).

- Spray when adjacent susceptible vegetation is mature or not present.
- Use a drift control agent.

14-21. DRIFT CONTROL AGENTS

A number of drift control agents are now available which reduce the potential for drift. These are described here.

a. Foams. Several foam additives and air-inducing nozzle systems are now available to apply chemicals in low-expansion foam sprays. The large foam particles produced by these systems tend to limit drift. Caution must still be exercised, however, since some small particles may be produced and foam particles are much lighter than liquid droplets.

b. Invert Emulsions. An invert emulsion is a mixture in which water droplets are dispersed in oil. They are normally quite thick and thus less susceptible to drift. Special equipment is usually required for mixing and applying invert emulsions.

c. Thickeners. Spray additives such as cellulose, gels, and swellable polymers are used to produce large drops up to 5,000 microns.

14-22. SMALL DROPLETS

Any of these agents can be used with either ground or aerial spraying systems. It is important to note that none of the drift control agents totally eliminates the production of small droplets. Even though they may comprise only one or two percent of the total volume sprayed, these droplets still have the potential to cause significant adverse effects.

EXERCISES, LESSON 14

REQUIREMENT. The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. List five methods of pesticide application.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. Hand sprayers are used to apply pesticides in what two types of jobs?

   a. _____

   b. _____

3. Equipment used to apply pesticides to landscape plants, fruits, and vegetables is

   _____.

4. The equipment to be used for dispersing liquid and solid formulations over broad areas or areas inaccessible to wheeled vehicles is

   _____.

5. Rope wick applicators are effective for eliminating _____

_____

6. List two advantages of using granular applicators.

a. _____

_____

b. _____

_____

7. a. The fumigant smokes is used in _____

b. The process is that the containers are ignited and _____

_____

8. List three types of nozzles.

a. _____

b. _____

c. _____

9. List three drift control agents.

a. _____

b. _____

c. _____

10. _____ such as cellulose, gels, and swellable polymers are used as pesticide drift control agents.

END OF LESSON EXERCISES

	LESSON ASSIGNMENT
LESSON 15	Equipment Calibration Procedures.
LESSON ASSIGNMENT	Paragraphs 15-1 through 15-23.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to operate, maintain, and calibrate pesticide dispersal equipment IAW TM 5-629.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the references listed above, you should be able to: 15-1. Define equipment calibration. 15-2. List five advantages of having accurately calibrated pesticide dispersal equipment. 15-3. Determine the amount of pesticide to apply per acre by: ◆ Boom sprayer. ◆ Granular applicator. ◆ Band or In-furrow applications. ◆ Backpack sprayers. ◆ Two-gallon sprayers. ◆ Ultra low volume (ULV) sprayers.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 15

EQUIPMENT CALIBRATION PROCEDURES

Section I. INTRODUCTION

15-1. GENERAL INFORMATION

a. Calibration and Pesticide Equipment. Calibrating pesticide application equipment is the important practice of ensuring that the correct amount of pesticide is applied over a specified area. Calibration procedures are essentially the same exercise for any type of equipment and for any pesticide formulation.

b. Definition. Calibration is a measure of the amount of pesticide applied to a specified area under a given set of conditions. For ultra low volume sprayers, calibration also includes a measure of pesticide droplet size under a given set of conditions.

◆ Effective control. If too little pesticide is applied, the pest will not be adequately controlled.

- Money saved. If too much pesticide is applied, money is wasted on unnecessary amounts of pesticide.

- Reduced risk of phytotoxicity. Damage to nontarget plants can result from too much pesticide applied in a single treatment or accumulated in several applications.

- Avoid legal liability. It is simply against the law to apply pesticides at rates higher than the pesticide label specifies.

- Safety. People, pets, and wildlife may be exposed to excessive pesticide levels when reentering the treated area if too much pesticide is used.

15-2. "TEST CALIBRATE" BEFORE USE

All new pesticide equipment should be calibrated before its first use. Calibrate seasonal equipment at the beginning of each season (e.g., prior to the first application in spring).

- Equipment in continuous use should be calibrated semiannually, especially if it is new equipment that has not been used before. Equipment manufacturers provide instructions and reference material that give suggested tractor speed, pump pressure, nozzle types, and other settings that will approximate the intended delivery rate. These can be used initially in the calibration test.

- For older equipment, the settings, tractor speed, and nozzles used in the previous season can be initially used in the calibration test.

NOTE: Do not assume the equipment will operate exactly as it did when last used. Changes in delivery rates can be expected from normal wear and tear of the equipment and other factors.

15-3. CALIBRATION TESTS APPROXIMATE DELIVERY RATE

Regardless of the pesticide application equipment used, calibration tests only approximate the delivery rate of the equipment. The delivery rate of pesticides, as well as fertilizers, needs to be continually monitored and fine-tuned while operating in the field. Sudden changes in delivery rates indicate equipment problems such as pump failure, plugged lines, plugged feed mechanisms, or hose leaks.

15-4. APPLICATION EQUIPMENT - PRECISE ADJUSTMENT FOR LARGE ACREAGES

Application equipment can be precisely adjusted when large acreages are treated.

- Example. Suppose an 80-acre area of turf grass, has just been sprayed with a weed killer.

  -- The intended rate of application is one quart of formulated product per acre.

  -- The sprayer is set to deliver five gallons of mix (water + pesticide) per acre.

- The golf course manager calculated that 20 gallons of weed killer mixed with 380 gallons of water is the exact amount of material required to deliver the rate of one quart formulated product per acre.

- However, after the area was sprayed, the golf course manager noted that 20 gallons of mix remained in the tank. Only 95 percent of the intended amount of weed killer was applied.

- The golf course manager could reduce the tractor speed slightly or increase the pump pressure a small amount to fine tune the sprayer.

- These adjustments can be made during the application since most golf course managers know how many swaths make up an acre, and most sprayers display the amount of mix present in the tank.

Section II. DETERMINING THE AMOUNT OF PRODUCT NEEDED

15-5. WHY DETERMINE PRODUCT AMOUNT

Determining the correct amount of formulated pesticide needed to treat an area of turf grass is very important in calibrating pesticide equipment. By purchasing the exact amount of pesticide needed to treat the total number of acres and then using all of the pesticide at the recommended or scheduled rate, you can avoid any problems with storing or disposing of leftover pesticides.

15-6. CALCULATION FORMULAS

- **The Equation.** The equation to calculate the number of pounds of dry formulation or gallons of liquid formulation, when the recommended rate is given as an amount of formulated product per acre, is as follows:

pounds or gallons needed	=	acres to be treated	x	recommended rate	÷	conversion factor (F)

- **The Conversion Factor (F).** The conversion factor (F) is used to transform recommended units to gallons or pounds. The values of F are as follows:

F = 1, when recommendations are given in pounds or gallons per acre.

F = 4, when recommendations are given in quarts per acre.

F = 8, when recommendations are given in pints per acre.

F = 16, when recommendations are given in dry ounces per acre.

F = 128, when recommendations are given in fluid ounces per acre.

- **Example.**

The number of pounds of formulated product needed to treat 80 acres at the recommended rate of 12 dry ounces of formulated product per acre is 60 pounds.

80 acres x 12 dry ounces ÷ 16 (F factor) = 60 pounds

15-7. CALIBRATING BOOM SPRAYERS

The following sections will explain how to calibrate boom and air blast sprayers, and granular applicators.

◆ **The Steps.** The steps for calibrating a boom sprayers are:

STEP 1. Check to be sure that all nozzles are made by the same manufacturer and have the same part number.

STEP 2. Thoroughly clean all screens and nozzles.

STEP 3. Fill the sprayer tank with water and check the uniformity of the spray patterns of all the nozzles. Check the volume of delivery of each nozzle by placing identical containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill at the same rate.

STEP 4. Select an operating tractor speed (generally three to five mph). Note the tachometer reading and gear use.

STEP 5. Select an operating pump pressure. Adjust the pressure to the desired psi while the pump(s) are operating at normal speed and water is actually flowing through the nozzles.

STEP 6. Measure and record the width of the swath covered by the sprayer.

STEP 7. Measure and mark off a course that is at least 200 feet or longer.

STEP 8. Using a stop watch, measure the amount of time it takes the sprayer to cover the course. Be sure the sprayer is moving at the speed selected in STEP 4 when it crosses the beginning of the course. Do not start from a dead stop at the beginning of the course.

STEP 9. With the sprayer standing still and operating at the selected pump pressure, collect the water from several nozzles for the exact number of seconds determined.

STEP 10. Pour all of the water collected in STEP 9 into a calibration jar or large measuring cup and measure the amount collected. Determine average output for a single nozzle by dividing the total amount collected by the number of nozzles from which the water was collected in STEP 9.

STEP 11. Determine the total amount of water sprayed for all nozzles by multiplying the average amount for one nozzle calculated in STEP 10 by the total number of nozzles on the boom. This value is an estimate of the total amount of spray delivered over the test course.

STEP 12. Convert the amount determined in STEP 11 to gallons per acre using the equation on the top of the next page.

- **The Formula.** Shown below is a simple method for calculating gallons of pesticide applied per acre.

gallons per acre	=	total amount of water sprayed	÷	length of course (feet)	÷	width of swath (feet)	x	conversion factor (F)

15-8. THE CONVERSION FACTOR

- **The Factor.** The conversion factor (F) is used to transform the amount measured in the test to gallons per acre. For this equation, the values used for the conversion factor are as follows:

F = 340.3, when the amount determined in STEP 10 is in fluid ounces.

F = 5,445, when the amount determined in STEP 10 is in pints.

F = 10,890, when the amount STEP 10 is in quarts.

F = 43,560, when the amount STEP 10 is in gallons.

- **Example.**

35.5 pints of water were applied in a calibration test that covered a course 800 feet long and 20 feet wide.

The number of gallons of water or spray delivered per acre is calculated as follows:

35.5	÷	800	÷	20	x	5,445	= 12.08 gallons per acre
pints of water		long		wide		(F)	

15-9. TOO LITTLE SPRAY DELIVERED

If the estimated amount of spray delivered is too little, it can be increased by one or a combination of the following:

- Increase pump pressure.
- Decrease tractor speed.
- Replace nozzles with nozzles that have a larger orifice.

15-10. TOO MUCH SPRAY DELIVERED

If the estimated amount of spray delivered is too large, it can be decreased by one or a combination of the following:

- Decrease pump pressure.
- Increase tractor speed.
- Replace nozzles with nozzles that have a smaller orifice.

15-11. RUN ANOTHER CALIBRATION TEST FOLLOWING ADJUSTMENTS

Be sure to run another calibration test if any of these adjustments are made. Once the sprayer is delivering a satisfactory rate, calculate the number of acres that can be treated by one tankful by the following equation:

treated acres per tank	=	tank capacity (gallons)	÷	application rate (gallons/acre)

15-12. EXAMPLE

- **Number of Acres to be Treated by One Tankful.** Using the value of 12.08 gallons per acre determined in the previous example and a sprayer tank size of 400 gallons, the number of acres that can be treated by one tankful is 33.11 acres (400 divided by 12.08).
- **Amount of Pesticide to be Added to the Tank.** To determine the amount of pesticide to be added to the tank to spray 33.11 acres, multiply the number of acres treated with one tankful by the recommended pesticide rate.
- **Example - Pesticide Added to the Tank.** If the recommended rate of pesticide is 1 quart/ acre in the above example, 33.11 quarts or approximately 8.25 gallons of formulated pesticide would be added to the tank.

15-13. CALIBRATION DIFFERENT FROM SPRAYERS

Calibrating granular applicators is somewhat different than for sprayers. Because the material is applied "as is" and not mixed with water or other carriers and the size of granules differ among different formulations and manufacturers, the exact same material that is to be applied must be used in the calibration test. Special care must be taken when handling these materials during the calibration test.

15-14. THE PROCESS

◆ **The Steps**. For broadcast granular applications, follow these steps:

STEP 1. Measure the width of the swath covered by the broadcast applicator.

STEP 2. Measure and mark off a test course. Since the actual pesticide is used for the calibration test, the course should be laid out in a field that is to be treated with the same pesticide. If the field is to have headlands, this area is recommended for the test course.

STEP 3. Disconnect the spreading mechanism (if one is used) and attach a catch pan, plastic bag, or other container that will not break or spill.

STEP 4. Operate the applicator at the desired settings and ground speed with the same pesticide to be applied. Be sure to operate only over the test course and to catch all the material that flows through the unit.

STEP 5. Weigh the material collected on a postal scale or other sensitive instrument.

STEP 6. Convert the amount weighed to pounds per acre using the following equation:

pounds per acre	=	total amount material applied	÷	length of course	÷	width conver. of swath	x	factor (F)

15-15. THE CONVERSION FACTOR

- **The Factor.** The conversion factor (F) is used to transform the amount measured in the test to pounds per acre. For this equation, the values used for the conversion factor are as follows:

> F = 2,723, when the amount determined in STEP 5 is in dry ounces.
>
> F = 43,560, when the amount determined in STEP 5 is in pounds.

- **The Example.**

> The number of pounds applied per acre in a calibration test where 7 ounces of granular pesticide were collected over a test course 500 feet long with a swath 20 feet wide, is 1.90 pounds per acre. If this amount is different from the recommended rate, the setting should be adjusted accordingly.
>
> Formula (from STEP 6 on the previous page):

pounds per acre	=	total amount material applied	÷	length of course	÷	width conver. of swath	x	factor (F)
pounds per acre	=	7 ounces	÷	50 feet	÷	20 feet	x	2,723
pounds per acre	=	1.90						

15-16. BAND OR IN-FURROW APPLICATIONS

◆ **The Steps.** For band or in-furrow granular applications, follow these steps:

STEP 1. Measure and mark off a test course of 1,000 feet.

STEP 2. Disconnect all the drop tubes and collect the granules in bags or cans while operating over the test course.

STEP 3. Weigh the material collected on a postal scale or other sensitive instrument. If the length of the test course was not 1000 feet, calculate the amount of pesticide that would have been applied to 1000 feet by using the following equation:

ounces per 1,000 ft	=	measured amount applied in test	÷	length of course	x	conversion factor (F)

◆ **The Conversion Factor.** The values to be used for the conversion factor (F) are:

F = 16,000, when measured in pounds.

F = 1,000, when measured in dry ounces.

◆ **Example.**

The number of ounces that would be applied to 1,000 feet where 8 ounces is collected over a test course of 500 feet, is 16 ounces (8 + 500 x 1,000).

STEP 4. If the recommended rate is given as an amount per acre, convert the recommended rate per acre to ounces per 1,000 row feet using the following equation:

dry ounces per 1 000 row feet	=	recommended formulated product per acre	x	row width	x	conver. factor (F)

- **The Conversion Factor.** The conversion factor (F) is used to transform the recommended units per acre to dry ounces per 1,000 row feet. The values of F for this equation are:

> F=0.03061, when the recommendations are in pounds per acre.
>
> F= 0.001913, when the recommendation are in dry ounces per acre.

- **Example.**

> For example, the number of dry ounces of formulated pesticide needed to treat 1,000 row feet in a field with 36-inch rows, when the recommended rate is 2 pounds of formulated product per acre, is 2.20 ounces (2 x 36 x 0.03061).

STEP 5. Compare the recommended rate calculated in STEP 4 to the test rate calculated in STEP 3. Adjust the settings if these values are different. Repeat the test until the recommended values and test values are equal.

15-17. THE METHOD

While it is not always necessary to calibrate a backpack sprayer depending on the type of application to be done, it can be done by the method listed below. Each operator must calibrate each backpack sprayer according to his walking speed in the following manner.

15-18. THE STEPS

STEP 1. Measure an area that is 10 feet by 43.6 feet. Record the time it takes for you to spray the entire area and the amount of product used.

Example: At your normal pace, you apply 0.5 lbs/ 436ft^2 in 5 minutes.

STEP 2. Now, use the label to find the amount of product to be applied over a given area (2lbs/1000ft^2).

STEP 3. Use your knowledge from STEPS 1 and 2 to determine the amount of product needed for the target area site (2000ft^2). So,

$$\frac{2\text{lbs}}{1000\ \text{ft}^2} = \frac{x\ \text{lbs}}{2000\ \text{ft}^2}$$

$$1000x = 4000$$

$$x = 4 \text{ pounds}$$

STEP 4. Now, you need to apply 4 lbs of product to the 2,000 ft^2 area. If you would apply the product at your normal walking pace, you would apply 0.5 lb of product to 463ft^2. Therefore, you would need to slow your pace down accordingly (in this case by almost half) to apply the pesticide in the required concentration.

15-19. THE METHOD

While it is not always necessary to calibrate a 2-gallon sprayer depending on the type of application to be done, it can be done by the following method. Each operator must calibrate each 2-gallon sprayer according to his walking speed in the following manner.

15-20. THE STEPS

STEP 1. Measure an area that is 10 feet by 43.6 feet. Record the time it takes for you to spray the entire area and the amount of product used.

Example: At your normal walking pace, you apply 20oz/436ft^2 in 10 minutes.

STEP 2. Find the application rate for the pesticide (2 pints/ acre); target site area (2,500 ft^2); and the tank capacity (2 gallons).

STEP 3. Calculate the amount of active ingredient needed to treat the target site area:
2 pints/ acre = 32 oz / 43,560 ft^2

$$\text{So,} \quad \frac{32 \text{ oz}}{43{,}560 \text{ ft}^2} = \frac{x \text{ oz}}{2{,}500 \text{ ft}^2}$$

$$43{,}560x = 80{,}000$$

$$x = \frac{80{,}000}{43{,}560}$$

$$x = 1.84 \text{ oz}$$

STEP 4. Calculate the amount of product needed to treat the target area:

$$\text{So,} \quad \frac{20 \text{ oz}}{436 \text{ ft}^2} = \frac{x \text{ oz}}{2{,}500 \text{ ft}^2}$$

$$436x = 50{,}000$$

$$x = \frac{50{,}000}{436}$$

$$x \text{ oz} = 114.6 \text{ oz product}$$

So, you will mix 1.84 oz of active ingredient with 112.76 oz diluent to obtain 114.6 oz of product.

STEP 5. Now, you need to apply 114.6 oz of product to the 2,500 ft^2 area. If you would apply the product at your normal walking pace, you would apply 20 oz of product to 436 ft^2. Therefore, you would need to slow your pace down accordingly (in this case just slightly) to apply the pesticide in the required concentration.

Section VII. CALIBRATION OF ULV SPRAYERS

15-21. CALIBRATION FACTORS

a. Information. Calibration of ULV sprayers differs from that of other sprayers by requiring pesticide for the procedure. Technical grade pesticides are used in ULV operations, and different pesticides have different viscosities. Because of this, you must calibrate a ULV sprayer for each pesticide you use. Since you use concentrated pesticide, you must wear full protective equipment during the calibration process including appropriate respirator, goggles, coveralls, hard hat, rubber apron, rubber gloves, rubber boots, and hearing protection. Calibration of the ULV sprayer consists of two parts: flow rate calibration and droplet size calibration.

b. Calibration Factors. There are three factors that affect ULV calibration:

- Air flow--governed by the blower speed.
- Flow rate--governed by the speed of the liquid pump.
- Pesticide viscosity.

15-22. THE METHOD

a. Calibration Part I--Flow Rate.

STEP 1. Calculate the amount of pesticide required for the target site and pour into tank.

STEP 2. Start sprayer and adjust to 3 to 4 psi or adjust rotary sleeve above 10,000 RPM.

STEP 3. Calculate flow rate to achieve desired application rate at predetermined vehicle speed.

NOTE: The swath width of a ULV sprayer is 300 feet.

STEP 4. Disconnect the hose at the nozzle.

STEP 5. Measure pesticide flow rate into a graduated cylinder for one minute.

STEP 6. Adjust pump flow rate to match the pre-calculated flow rate (STEP 3).

STEP 7. Repeat STEPS 5 and 6 until proper flow rate is achieved.

STEP 8. Repeat calibration process any time you change pesticide.

b. Calibration Part II - Droplet Size.

Droplet size calibration requires Teflon-coated microscope slides, acetone, a 36 inch wand with a binder clip at its end, a microscope, and a micrometer.

STEP 1. Clean microscope slides with acetone.

STEP 2. Measure a distance of 15 or 25 feet from the nozzle according to label recommendations.

STEP 3. Attach microscope slide to wand clip.

STEP 4. Turn on sprayer with pump set at pre-determined flow rate and nozzle fixed in a horizontal position.

STEP 5. Swing slide through fog with an upward motion from the distance recommended by the label. Repeat.

STEP 6. Measure droplet size with a microscope and micrometer, and compare with label specifications.

NOTE: Do not measure droplets from the edge of the slide.

STEP 7. Repeat process for each pesticide formulation you use.

15-23. CLOSING

Modern, high quality pesticide dispersal equipment is designed to be durable and dependable. However, it is up to you to see that it meets manufacturer's specifications, and that your pesticide applications meet legal requirements.

EXERCISES, LESSON 15

REQUIREMENT. The following exercises are to be answered by selecting the correct letter, completing the incomplete statement, or by writing the answer in the space provided at the end of the question. After you have completed all the exercises, turn to Appendix F and check your answers.

1. Calibrating pesticide application equipment is the practice of _____

_____

_____

_____

2. List three advantages of having properly calibrated dispersal equipment.

a. _____

_____

_____

b. _____

_____

_____

c. _____

_____

_____

3. You have just purchased a new boom sprayer and need to calibrate it. Traveling at a constant speed of 3 mph with the pump set at 25 psi, you apply 9.3 quarts of water to a test course measuring 1000 feet long by 10 feet wide. What is the application rate per acre?

4. What should you do if you want the application rate to be 15 gallons/acre?

_____

_____

_____

_____

END OF LESSON EXERCISES

LESSON ASSIGNMENT	
LESSON 16	Pesticide Calculations.
LESSON ASSIGNMENT	Paragraphs 16-1 through 16-3.
TERMINAL LEARNING OBJECTIVE	Information gained in this lesson should enable you to perform calculations necessary to apply pesticides legally IAW TIM 24.
SPECIFIC LESSON OBJECTIVES	After completing this lesson IAW the reference listed, you should be able to: 16-1. Calculate pesticide formulas.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 16

PESTICIDE CALCULATIONS

16-1. INTRODUCTION

Most pesticide calculation problems will involve basic arithmetic. Pest managers must also be able to calculate areas, volumes, perimeters, and solve simple algebraic equations.

16-2. AREA, VOLUME, AND PERIMETER FORMULAS

Most pesticide calculation problems will involve basic arithmetic such as addition, subtraction, multiplication, and division. Pest managers must also be able to calculate areas, volumes, and perimeters, and solve simple algebraic equations.

a. Area. This is a measure of surface. The pest manager may have to treat a floor space or an outside area such as a parade field or golf course fairway. In either situation, knowing the area is necessary before the pesticide dosage can be calculated. To do an area calculation, determine the geometrical shape of the area, then use the formula applying for that shape.

Rectangle: Area	=	Length x Width (A=lw)
Triangle: Area	=	½ Base x Height (A=½bh)
Circle: Area	=	Pi x Radius squared ($A=\pi r^2$)

NOTE. Oddly shaped areas may be handled by dividing the total area into sections and calculating the area of each section. Then, add the area of all sections together to get the total area.

b. Volume. This is a measure of a 3-dimensional space. Pest managers must often apply pesticide within an enclosed space, such as a warehouse. To calculate the pesticide dosage, you must know the volume within the enclosed space. The following formulas are used to calculate volume.

Rectangle: Volume	=	Length x Width x Height (V=lwh)
Cylinder: Volume	=	Pi x Radius squared x Height ($V=\pi r^2 h$

c. Perimeter. This is a measure of linear distance. To determine perimeter, simply add the lengths of all sides of the geometric figure. The perimeter, or circumference, of a circle is found by multiplying 2 x Pi x Radius ($C=2\pi r$).

d. Proportions.

- Many pesticide mixing formulations before applicating the pesticide. Determining the correct formulation mixture may be determined through the use of proportions, or equal ratios. Four numbers, represented by a, b, c, and d, are said to be in proportion if a/b = c/d. This proportional relationship can be used to solve most commonly encountered pesticide application problems. For example, imagine you must treat an area of 1,800 ft^2 for a fungus infestation. The label prescribes 5 gallons of finished spray for 10,000 ft^2.

- To find the amount of finished spray required for our area, we can use the proportion:

$$\frac{5 \text{ gallons}}{10{,}000 \text{ ft}^2} = \frac{x}{1800 \text{ ft}^2}$$

-- Solve this proportion for X. Therefore,

$$5 \text{ gallons } (1800 \text{ ft}^2) \div 10000 \text{ ft}^2 = x$$

$$9000 \text{ gallons ft}^2 \div 10000 \text{ ft}^2 = x$$

$$0.9 \text{ gallons} = x$$

ANS. 0.9 gallons of finished spray will be needed to treat 1800 ft^2.

e. Fertilizer Plus an Herbicide Product.

- Now consider a more involved problem dealing with application of a fertilizer plus herbicide product. The label allows 163 to 280 pounds per acre for control of crabgrass, foxtail and other warm season weeds. You intend to apply the heaviest allowable treatment. You will treat two rectangular areas, one measuring 930 ft by 186 ft and the other 690 ft by 102 ft.

- To determine the amount of fertilizer plus herbicide which will be required, we initially determine the area to be treated.

Determine the area to be treated.

930 ft x 186 ft = 172,980 ft^2

690 ft x 102 ft = 70,380 ft^2

Total Area = 172,980 ft^2 + 70,380 ft^2 = 243,360 ft^2

Convert square footage to acreage (1 acre = 43,560 ft^2):

243,360 ft^2 ÷ 43,560 ft^2 = 5.6 acres

Now use the proportion 280 lbs/acre = x lbs/5.6 acres and solve for the unknown.

Therefore, x lbs = (280 lbs/acre) 5.6 acres
= 1568 lbs

16-3. DILUTION FORMULAS

It is usually necessary to dilute concentrated pesticides to achieve a less concentrated finished spray. Modern pesticides labels often do the mathematics for the user; however, if this assistance is not available, three formulas are used to calculate almost any pesticide dilution.

a. Weight to Volume. Weight to volume basis for diluting concentrates to make suspensions or dilutions.

Formula 1: $W = \frac{8.34 \times A \times S}{C}$

Where: 8.34 = Constant (weight of 1 gallon of water)
Q = Weight in pounds of concentrate
A = Gallons desired
C = % of active ingredient in concentrate
S = % of active ingredient in finished spray

Example: How many pounds of 80% Carbaryl water wettable powder will be used to obtain 100 gallons of a 2% spray?

$$Q = \frac{8.34 \times 100 \times 2}{80}$$

$$Q = 20.85$$

b. Weight to Weight or Volume to Volume. Weight to Weight or Volume to Volume for diluting dust in a dust or liquid in a liquid.

Formula 2: $Q = \frac{A \times S}{C}$

Where:
- Q = Weight or Volume of Concentrate.
- A = Total weight or volume of finished spray.
- C = % of active ingredient in concentrate.
- S = % of active ingredient in finished spray.

Example: How much 95% concentrate will you use to obtain 200 gallons of 1% Malathion to be diluted with fuel oil?

$$Q = \frac{A \times D}{C} = \frac{200 \times 1}{95} = 2.1 \text{ gallons} = 2 \text{ gallons and 13 ounces}$$

c. Diluting Liquid Concentrates. Diluting liquid concentrates which are prepared on the basis of pounds of insecticides per gallon.

Formula 3: $\frac{S \times A \times D}{C \times W} = Q$

Where:
- Q = Quantity of concentrate required in gallons.
- S = % of active ingredient in finished spray.
- A = Amount of spray to be prepared in gallons.
- D = Density of one gallon of diluent (usually water).
- C = % of active ingredient in concentrate.
- W = Weight of actual pesticide (in pounds) in each gallon of concentrate. This is usually found on the LABEL.

Example: Ten gallons of a 2% emulsion are desired. The concentrate contains 8 lbs/gal of active ingredient. How much liquid concentrate is required?

$$Q = \frac{S \times A \times D}{C \times W} = \frac{2 \times 10 \times 8.34}{100 \times 8} = \frac{166.8}{800} = 0.21 \text{ gallons (26.88 oz)}$$

NOTE. Most pesticides are sold with the label indicating pounds per gallon of pesticide and the percentage of toxic materials. In this case modify the formula so that C is considered Technical grade insecticide (100%).

LESSON 16, ANNEX A - PESTICIDE CALCULATION FORMULAS

Dilution Formulae

1. **Solids with Solids or Liquids with Liquids.**

When mixing solid with solid (dusts) or liquid with liquid (emulsions, solutions), use:

$$Q = \frac{S \times A}{C} \quad \text{or} \quad C \times Q = S \times A$$

2. **Solid with Liquid.**

When mixing solid with liquid (WWP, suspensions), use:

$$Q = \frac{S \times A \times D}{C} \quad \text{or} \quad C \times Q = S \times A \times D$$

3. **Liquids with Concentrates.**

When mixing liquids with concentrates whose concentration is expressed in pounds of pesticide per gallon, assume 100 percent concentration and use:

$$Q = \frac{S \times A \times D}{C \times W} \quad \text{or} \quad C \times W \times Q = S \times A \times D$$

Q = quantity (gallons, pounds) of concentrate required.
S = strength (percent) active ingredient in finished spray or duet.
A = amount (gallons, pounds) of total finished spray or dust.
D = density (pounds/gallon) of diluent (water—8.34 pounds/gallon; kerosene—6.6 pounds/gallon).
C = strength (percent) active ingredient in concentrate.
W = weight (pounds/gallon) active ingredient per gallon of concentrate.

LESSON 16, ANNEX B - FORMULAS AND EQUIVALENTS

1. **Formulas Pertaining to Rectangles and Squares.**

   - Perimeter (Linear Measurement) = (2 x Length) + (2 x Width)
   - Area (Square Measurement) = Length x Width
   - Volume (Cubic Measurement) = Length x Width x Height

2. **Measures of Length (Linear):**

   1 inch (in) = 2.54 centimeters = 25.4 millimeters
   1 foot (ft) = 12 inches = 30.5 centimeters = 0.3048 meters
   1 yard (yd) = 36 inches = 3 feet = 0.9144 meters
   1 mile (mi) = 5,280 feet = 1,760 yards = 1.8 kilometers
   1 micron = 0.001 millimeter
   1 millimeter (mm) = 0.1 centimeters = 0.0394 inch
   1 centimeter (cm) = 10 millimeters 0.01 meters = 0.394 inch
   1 meter (m) = 100 centimeters = 39.37 inches = 3.28 feet
   1 kilometer (km) = 1,000 meters = 0.6214 miles

3. **Measures of Area (Surface, Square):**

   1 square foot (sq ft) = 144 square inches = 0.0929 square meter
   1 square yard (sq yd) = 1,296 square inches = 9 square feet = 0.8361 square meter
   1 acre (A) = 43,560 square feet = 4,840 square yard = 0.4047 hectare
   1 square mile (sq mi) = 640 acres = 259 hectares
   1 square meter (sq m) = 1,550 square inches
   1 hectare = 10,000 square meters = 2,471 acres
   1 square kilometer (sq km) = 1,000,000 square meters = 0.3861 square miles .1212 acres in area one mile long by one feet wide

4. **Measures of Volume (Cubic):**

   1 cubic inch (cu in) = 16-387 cubic centimeters (cc)
   1 cubic foot (cu ft) = 1,728 cubic inches = 28.316 liters
   1 cubic yard (cu yd) = 27 cubic feet = 764.5 liters
   1 milliliter (mi) = 1 cubic centimeter (cc) = 0.001 liter
   1 liter (1) = 1,000 ml = 1.057 liquid quart (US)

5. **Measures of Volumes (Liquid, US):**

   1 tablespoon (T) = 3 teaspoons (t)
   1 cup = 16 tablespoons = 8 fluid ounces = 0.5 pint
   1 pint (pt) = 16 fluid ounces = 2 cups = 473.2 milliliters
   1 quart (qt) = 32 fluid ounces = 4 cups = 2 pints = 0.9463 liter
   1 gallon (gal) = 128 fluid ounces = 8 pints = 4 quarts = 3.785 liters
   1 fluid ounce (fl oz) = 16 drams = 2 tablespoons = 29.57 milliliters
   1 gallon (UK) = 4 quarts (UK) = 1.2009 gallons (US) = 4.541 liters

6. **Measures of Volume (Dry, US):**

1 quart = 2 pints = 1.1012 liters
1 bushel (bu) = 32 quarts = 4 pecks = 1.244 cubic feet = 35.238 liters
1 liter = 0.9081 dry quart

7. **Measures of Mass (Weight):**

1 ounce (avoirdupois) = 28.3495 grams
1 pound (lb) (avoirdupois) = 16 ounces = 453.59 grams
1 ton (short) = 2,000 pounds = 0.893 long ton = 0.9072 metric ton = 907.2 kilograms
1 microgram = 0.001 milligram
1 milligram (mg) = 1,000 gammas = 0.001 gram
1 gram (g) = 1,000 milligrains = 0.0353 ounce (av)
1 kilogram (kg) = 1,000 grams = 35.27 ounces (av) = 2.205 pounds (av)
1 metric ton = 1,000 kilograins = 1.1023 short tong
1 milligram/kilogram = 1 part/million
1 pound/cubic foot = 0.26 gram/cubic inch
1 gram/cubic inch = 3.78 pounds/cubic foot

8. **Density and Specific Gravity:**

Density—weight per unit volume. Density of water at 4° C = 1 q/cc

Specific Gravity—density of a solid or liquid divided by the density of water. The specific gravity of water = 1.

Density of Water = 8.34 lbs/gal

Density of Kerosene = 8.8 lbs/gallon

EXERCISES, LESSON 16

REQUIREMENT. Read the test items which follow and complete the calculations. After you have completed all the exercises, turn to the Solutions to Exercises, Lesson 16 on page 16-20 and check your answers.

1. The warehouse area that measures 36 feet high by 65 feet wide by 180' long. You are to treat this area with 5% Vapona[R] insecticide. The application rate is ½ ounce per 1000 cubic feet. How much insecticide will you use to treat this space.

2. You need to spray 3 feet up the walls in a room 30 feet by 40 feet. If the application rate is 2 gallons/1000 square feet, how many gallons do you need?

3. What is the volume of a room 84 feet by 48 feet with a 28 feet ceiling?

4. What is the perimeter of a building 91 feet long and 31 feet wide?

5. How many acres are in an area 12 miles long and 35 feet wide?

6. You are to dust for fleas with 4 percent malathion dust at a rate of 2 pounds per 1000 square feet. How much dust will you need for 6500 square feet?

7. You are to fumigate a building the dimensions of which are 50 feet by 30 feet with a 10 foot high ceiling. What is the volume of this building?

8. You need to treat wall surfaces to a height of 3 feet in a room that measures 30 feet by 20 feet. The room has 8 foot ceilings. How many square feet will you need to treat?

9. Use your answer in problem 8 to figure how much malathion you will use to treat walls at the rate of 1 gallon per 1000 square feet.

10. How many acres are in an area 2 miles by 10 feet? (Remember: 1 acre = 43,560 square feet. 1 mile = 5,280 feet)

11. You have only 1 ½ pints of herbicide Roundup^{R}. You will need to do a broadcast application to control weeds that are < 6 inches tall. The area measures 209 feet square. The application rate is 1 ½ pints per acre. Do you have enough herbicide? Show all work.

12. You are to treat an area of standing water with ABATE 4E^{R} mosquito larvacide. Waters are high in organic matter. The area is roughly circular with a diameter of 2260 feet. If the application rate is 4 ounces per 2000 square feet, how much ABATE 4E^{R} will you use?

13. You are going to perform a post-construction treatment for termites around the slab-on-grade barracks at your installation. You will use a 1 percent emulsion of Dursban TC[R]. The application rate is 4 gallons emulsion (final mixture) per 10 linear feet. The outside dimensions of the barracks are 25 feet by 100 feet. How much Dursban TC[R] will you require? How much water?

14. You are the Camp Swampy greenskeeper. The camp Commander is an avid golfer. To your horror you discover large brown patches on 11 of your 18 greens, 16 days before the camp Commander's Gold Scramble. Your greens are roughly circular with a diameter of 30 feet. In an effort to avoid a private meeting with the Commander, you decide to treat the greens with the fungicide Tersan[R] twice during the next 16 days. Directions on the label give the rate of 2 ounces concentrate/1000 square feet. How much Tersan[R] will you use?

15. You are the land manager at Fort Knocks, Kentucky. The parade field is overgrown with crabgrass, which you will treat next spring with Balan[R] granular premergent weed control. The parade field measures 710 feet by 435 feet. You will use the maximum treatment—120 pounds per acre. How many bags of Balan[R] will be necessary? Each bag weighs 40 pounds.

16. You are using Ficam+[R] to treat the perimeter of your installation headquarters to control an infestation of crawling insects and other arthropods. You will treat a band of soil 10 feet wide around the building. You will also treat the building walls to a height of 3 feet. You have found that one gallon of mix will treat 220 square feet. The building is a rectangle measuring 116 feet by 59 feet. How many gallons of mix will you use?

17. You have deployed to a foreign country. The Task Force Commander has directed that the battalion aid station will be set up in an abandoned barracks. There is a heavy infestation of ants and cockroaches. The barracks consists of two wings: one measuring 178 feet by 49 feet; the other measuring 210 feet by 49 feet. You will treat the baseboards with Ficam±[R]. Experience has shown that 1 gallon of mix will treat 90 feet of baseboard. How much mix will you require?

18. The duck pond at Fort Runamok, Florida is heavily infested with algae. This pond is nearly rectangular with sides of 76 and 106 yards. Average depth is determined to be 4.5 feet. You will treat with 11 pounds of Hydout[R] per acre foot. How much Hydout[R] will be needed?

19. An outbreak of sylvatic plague on your installation requires that all rodent burrows around the landfill be treated for fleas. You will use 0.5 percent Permethrin^{R} dust. Experience shows that about 5 ounces of dust will treat one burrow. Counting burrows on a measured area, you find an average of 4 burrows per 1000 square feet. How much dust will you need to treat the 22 acres around the landfill?

20. The drainage canal at Camp Sasquatch is infested with submersed aquatic weeds; water movement is impeded. Treatment with Aquathol K^{R}at three parts per million should control the pest plants. Directions on the label state that 1.9 gallons of Aquathol K^{R} per acre foot will give a 3-part per million pesticide concentration. The canal is 4 feet deep by 3 feet wide and measures 560 yards long. How many gallons of Aquathol K^{R} will be needed?

21. You must control a saw-toothed grain beetle infestation in bagged flour. The flour is loaded aboard 27 boxcars, each one measuring 40 feet by 20 feet by 12 feet. At the recommended rate of 180 pellets per 1000 cubic feet, how many Phostoxin pellets will you require? It may be hard to count out this many pellets; therefore, if 180 pellets will fit in one envelope, how many envelopes will you use?

22. You are using a backpack sprayer to apply herbicide along a fence line. The spray width (or swath) is 3 feet; you are walking at 3 miles per hour (264 feet per minute). The sprayer will apply ½ quart or 16 ounces per minute. How many gallons will you apply per acre?

SOLUTIONS TO EXERCISES, LESSON 16

1. The warehouse area measures 36 feet high by 65 feet wide by 180' long. You are to treat this area with 5% Vapona^{R} insecticide. The application rate is ½ ounce per 1000 cubic feet. How much insecticide will you use to treat this space?

$$\text{Volume} = lwh$$
$$= 36 \text{ ft} \times 65 \text{ ft} \times 180 \text{ ft}$$
$$= 421{,}200 \text{ feet}^3$$

$$\frac{.5 \text{ oz}}{1000 \text{ ft}^3} = \frac{x}{421{,}200 \text{ sq ft}^3}$$

$$1000x = 210{,}600 \text{ oz}$$

$$x = 210{,}600 \text{ oz} \div 1000$$

$$x = 210.6 \text{ ounces of insecticide}$$

ANSWER: 210 ounces of insecticide

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2. You need to spray 3 feet up the walls in a room 30 feet by 40 feet. If the application rate is 2 gallons/1000 square feet, how many gallons do you need?

$$\text{Linear feet} = 30 \text{ ft} + 30\text{ft} + 40 \text{ ft} + 40 \text{ ft}$$
$$= 140 \text{ ft}$$

$$\text{Area} = 140 \text{ ft} \times 3 \text{ ft}$$
$$= 420 \text{ ft}^2$$

$$\frac{2 \text{ gal}}{1000 \text{ ft}^2} = \frac{x}{420 \text{ ft}^2}$$

$$1000x = 840 \text{ gal}$$

$$x = 840 \text{ gal} \div 1000$$

$$x = 0.84 \text{ gallons of pesticide}$$

ANSWER: 0.84 gallons of pesticide

3. What is the volume of a room 84 feet by 48 feet with a 28 feet ceiling?

Volume	=	lwh
	=	84 ft x 48 ft x 28 ft
	=	112,896 ft^3

ANSWER: 112,896 square feet

4. What is the perimeter of a building 91 feet long and 31 feet wide?

Perimeter	=	Linear feet
Perimeter	=	(2 x length) + (2 x width)
	=	(91 ft x 2) + (31 ft x 2)
	=	182 + 62
	=	244 ft

ANSWER: 244 linear feet

5. How many acres are in an area 12 miles long and 35 feet wide?

1 mile = 5280 ft
1 acre = 43,560 ft^2
.1212 acres in an area one mile long by one foot wide

Acres = $\frac{(12 \times 5280 \text{ ft}) \times 35 \text{ ft}}{43{,}560 \text{ ft}^2}$ Method 1.

= 50.9 acres

or Acres = .1212 x 12 x 35 Method 2.
= 50.9 acres

ANSWER: 50.9 acres

6. You are to dust for fleas with 4 percent malathion dust at a rate of 2 pounds per 1000 square feet. How much dust will you need for 6500 square feet?

$\frac{2 \text{ lbs}}{1000 \text{ ft}^2} = \frac{x}{6500 \text{ ft}^2}$

$1000x = 1300 \text{ lbs}$

$x = 1300 \text{ lbs} \div 1000$

$= 13 \text{ lbs}$

ANSWER: 0.13 pounds of insecticide

7. You are to fumigate a building the dimensions of which are 50 feet by 30 feet with a 10 foot high ceiling. What is the volume of this building?

Volume = lwh
= 50 ft x 30 ft x 10 ft
= 15,000 ft^3

ANSWER: 15,000 cubic feet

8. You need to treat wall surfaces to a height of 3 feet in a room that measures 30 feet by 20 feet. The room has 8 foot ceilings. How many square feet will you need to treat?

Area = lw (NOTE: ceiling height is irrelevant)
= (30 ft + 30 ft + 20 ft + 20 ft) x 3 ft
= 100 ft x 3 ft
= 300 ft^2

ANSWER: 300 square feet

9. Use your answer in problem 8 to figure how much malathion you will use to treat walls at the rate of 1 gallon per 1000 square feet.

$$\frac{1 \text{ gal}}{1000 \text{ ft}^2} = \frac{x}{300 \text{ ft}^2}$$

$$1000x = 300 \text{ gal}$$

$$x = 300 \text{ gal} \div 1000$$

$$x = 0.3 \text{ gallons}$$

ANSWER: 0.3 gallons of insecticide

10. How many acres are in an area 2 miles by 10 feet? (Remember: 1 acre = 43,560 square feet. 1 mile = 5,280 feet)

$$\text{Acres} = \frac{(2 \times 5280 \text{ ft}) \times 10 \text{ ft}}{43{,}560 \text{ ft}^3} \qquad \text{Method 1.}$$

$$= 2.4 \text{ acres}$$

or $\text{Acres} = .1212 \times 2 \times 10$ Method 2.

$$= 2.4 \text{ acres}$$

ANSWER: 2.4 acres

11. You have only 1 ½ pints of herbicide Roundup^R. You will need to do a broadcast application to control weeds that are < 6 inches tall. The area measures 209 feet square. The application rate is 1 ½ pints per acre. Do you have enough herbicide? Show all work.

1 Acre = 43,560 ft^2

Treated area = 209 ft x 209 ft

= 43,681 ft^2

ANSWER: **You do not have enough herbicide. However, the difference is so small, it would have little effect on control. It would also be legal since the application would be less than the maximum dose on the label.**

12. You are to treat an area of standing water with ABATE 4E^R mosquito larvacide. Waters are high in organic matter. The area is roughly circular with a diameter of 2260 feet. If the application rate is 4 ounces per 2000 square feet, how much ABATE 4E^R will you use?

Area of circle = πr^2

r = diameter ÷ 2

π = 3.14

Treated area = 3.14 x $(1130\ ft)^2$

= 4,009,466 ft^2

$$\frac{4\ oz}{2000\ ft^2} = \frac{x}{4{,}009{,}466\ ft^2}$$

2000x = 16,037,864 oz

x = 16,037,864 oz ÷ 2000

x = 8018.9 oz

ANSWER: 8018.9 ounces of Insecticide

13. You are going to perform a post-construction treatment for termites around the slab-on-grade barracks at your installation. You will use a 1 percent emulsion of Dursban TC[R]. The application rate is 4 gallons emulsion (final mixture) per 10 linear feet. The outside dimensions of the barracks are 25 feet by 100 feet. How much Dursban TC[R] will you require? How much water?

Linear feet = (25 ft x 2) + (100 ft x 2)

= 250 ft

$\frac{4 \text{ gal}}{10 \text{ ft}} = \frac{x}{250 \text{ ft}}$

10x = 1000 gal

x = 1000 gal ÷ 10

x = 100 gallons

ANSWER: 100 gallons of insecticide

14. You are the Camp Swampy greenskeeper. The camp Commander is an avid golfer. To your horror you discover large brown patches on 11 of your 18 greens, 16 days before the camp Commander's Gold Scramble. Your greens are roughly circular with a diameter of 30 feet. In an effort to avoid a private meeting with the Commander, you decide to treat the greens with the fungicide Tersan[R] twice during the next 16 days. Directions on the label give the rate of 2 ounces concentrate/1000 square feet. How much Tersan[R] will you use?

Area of circle = πr^2

r = diameter ÷ 2

π = 3.14

Treated area = [3.14 x $(15 \text{ ft})^2$ x 18*] x 2 treatments

= 25,434 ft^2

*NOTE: With fungus on 11 of 18 greens and foot traffic between greens, treat all greens.

$\frac{2 \text{ oz}}{1000 \text{ ft}^2} = \frac{x}{25{,}434 \text{ ft}^2}$

1000x = 50,868 oz

x = 50,868 oz ÷ 1000

x = 50.87 ounces

ANSWER: 50.87 ounces of fungicide

15. You are the land manager at Fort Knocks, Kentucky. The parade field is overgrown with crabgrass, which you will treat next spring with Balan^{R} granular premergent weed control. The parade field measures 710 feet by 435 feet. You will use the maximum treatment—120 pounds per acre. How many bags of Balan^{R} will be necessary? Each bag weighs 40 pounds.

$$1 \text{ Acre} = 43{,}560 \text{ ft}^2$$

$$\text{Treated area} = 710 \text{ ft} \times 435 \text{ ft}$$

$$= 308{,}850 \text{ ft}^2$$

$$\text{Acres} = 308{,}850 \text{ ft}^2 \div 43{,}560 \text{ ft}^2$$
$$= 7.1$$

$$\frac{120 \text{ lbs}}{1 \text{ acre}} = \frac{x}{7.1 \text{ acres}}$$

$$x = 852 \text{ lbs}$$

$$\text{Bags} = 852 \text{ lbs} + 40 \text{ lbs}$$
$$= 21.3$$

ANSWER: You need 22 bags.

16. You are using Ficam+^{R} to treat the perimeter of your installation headquarters to control an infestation of crawling insects and other arthropods. You will treat a band of soil 10 feet wide around the building. You will also treat the building walls to a height of 3 feet. You have found that one gallon of mix will treat 220 square feet. The building is a rectangle measuring 116 feet by 59 feet. How many gallons of mix will you use?

$$\text{Treated soil} = (136 \text{ ft} \times 10 \text{ ft} \times 2) + (59 \text{ ft} \times 10 \text{ ft} \times 2)$$
$$= 3900 \text{ ft}^2$$
$$\text{Treated walls} = [(116 \text{ ft} \times 2) + (59 \text{ ft} \times 2)] \times 3 \text{ ft}$$
$$= 1050 \text{ ft}^2$$
$$\text{Total treated area} = 3900 \text{ ft}^2 + 1050 \text{ ft}^2$$
$$= 4950 \text{ ft}^2$$

$$\frac{1 \text{ gal}}{220 \text{ ft}^2} = \frac{x}{4950 \text{ ft}^2}$$

$$220x = 4950 \text{ gal}$$

$$x = 4950 \text{ gal} \div 220$$

$$x = 22.5 \text{ gal}$$

ANSWER: 22.5 gallons of insecticide

17. You have deployed to a foreign country. The Task Force Commander has directed that the battalion aid station will be set up in an abandoned barracks. There is a heavy infestation of ants and cockroaches. The barracks consists of two wings: one measuring 178 feet by 49 feet; the other measuring 210 feet by 49 feet. You will treat the baseboards with Ficam+[R]. Experience has shown that 1 gallon of mix will treat 90 feet of baseboard. How much mix will you require?

Treated area = [(178 ft x 2) + (49 ft x 2)] + [(210 ft x 2) + (49 ft x 2)]
= 972 ft

$\frac{1 \text{ gal}}{90 \text{ ft}} = \frac{x}{972 \text{ ft}}$

90x = 972 gal

x = 972 gal ÷ 90

= 10.8 gallons

ANSWER: 10.8 gallons of insecticide

18. The duck pond at Fort Runamok, Florida is heavily infested with algae. This pond is nearly rectangular with sides of 76 and 106 yards. Average depth is determined to be 4.5 feet. You will treat with 11 pounds of Hydout[R] per acre foot. How much Hydout[R] will be needed?

$1 \text{ yd}^2 = 9 \text{ ft}^2$

1 Acre foot = $43{,}560 \text{ ft}^3$

Surface area = 76 yds X 106 yds

= 8056 yds^2

Square feet = 8056 X 9

= $72{,}504 \text{ ft}^2$

Volume = $72{,}504 \text{ ft}^2$ X 4.5 ft

= $326{,}268 \text{ ft}^3$

Acre feet = $326{,}268 \text{ ft}^3 \div 43{,}560 \text{ ft}^3$

= 7.5

$\frac{11 \text{ lbs}}{1 \text{ acre ft}} = \frac{x}{7.5 \text{ acre ft}}$

x = 82.5 lbs

ANSWER: 82.5 pounds of algicide

19. An outbreak of sylvatic plague on your installation requires that all rodent burrows around the landfill be treated for fleas. You will use 0.5 percent Permethrin^R dust. Experience shows that about 5 ounces of dust will treat one burrow. Counting burrows on a measured area, you find an average of 4 burrows per 1000 square feet. How much dust will you need to treat the 22 acres around the landfill?

1 Acre = 43,560 ft^2

Total treated area = 22 x 43,560 ft^2
= 958,320 ft^2

Total burrows = 958,320 ft^2 x $\frac{4}{1000}$
= 3833

Insecticide = 3833 burrows x 5 oz

= 19, 165 oz

= 1198 lbs

ANSWER: 1198 pounds of insecticide

20. The drainage canal at Camp Sasquatch is infested with submersed aquatic weeds; water movement is impeded. Treatment with Aquathol K^{R}at three parts per million should control the pest plants. Directions on the label state that 1.9 gallons of Aquathol K^R per acre foot will give a 3-part per million pesticide concentration. The canal is 4 feet deep by 3 feet wide and measures 560 yards long. How many gallons of Aquathol K^R will be needed?

1 Acre foot = 43,560 ft^3
560 yds = 1680 ft
Total volume = 1680 ft x 4 ft x 3 ft
= 20,160 ft^3

Acre feet = $\frac{20{,}160\ ft^3}{43{,}560\ ft^3}$
= 0.46 ft^3

Total pesticide = 0.46 acre ft x 1.9 gallons
= 0.87 gallons

ANSWER: 0.87 gallons of herbicide

21. You must control a saw-toothed grain beetle infestation in bagged flour. The flour is loaded aboard 27 boxcars, each one measuring 40 feet by 20 feet by 12 feet. At the recommended rate of 180 pellets per 1000 cubic feet, how many Phostoxin pellets will you require? It may be hard to count out this many pellets; therefore, if 180 pellets will fit in one envelope, how many envelopes will you use?

Total treated volume = (40 ft x 20 ft x 12 ft) x 27
= 259,200 ft^3

$\frac{180 \text{ pellets}}{1000 \text{ ft}^3} = \frac{x}{259{,}200 \text{ ft}^3}$

1000x = 46,656,000 pellets

x = 46,656,000 pellets ÷ 1000
= 46,656 pellets

Total envelopes = 46,656 ÷ 180
= 259.2

ANSWER: You need 260 envelopes.

22. You are using a backpack sprayer to apply herbicide along a fence line. The spray width (or swath) is 3 feet; you are walking at 3 miles per hour (264 feet per minute). The sprayer will apply ½ quart or 16 ounces per minute. How many gallons will you apply per acre?

Application rate = 3 ft x 264 ft per minute
= 792 ft^2 per minute

Time per acre: $\frac{1 \text{ minute}}{792 \text{ ft}^2} = \frac{x}{43{,}560 \text{ ft}^2}$

792x = 43,560 min
x = 43,560 min ÷ 792
x = 55 minutes

Oz per acre = $\frac{55 \text{ min}}{\text{acre}} \times \frac{16 \text{ oz}}{\text{min}}$
= 880 oz per acre

Gal per acre = $\frac{880 \text{ oz per acre}}{128 \text{ oz per gal}}$
= 6.88 gal per acre

ANSWER: Application is 6.88 gallons per acre.

APPENDIX A: PEST MANAGEMENT REFERENCES

1. CODE OF FEDERAL REGULATIONS

a. Title 29 CFR, 1994 rev., Part 1910.106, Flammable and combustible liquids.

b. Title 29 CFR, 1994 rev., Part 1910.141, Sanitation.

c. Title 29 CFR, 1994 rev., Part 1910.151, Medical services and first aid.

d. Title 29 CFR, 1994 rev., Part 1910.1200, Hazard Communication.

e. Title 40 CFR, 1994 rev., Part 156, Labeling Requirements for pesticides and devices.

f. Title 40 CFR, 1994 rev., Part 157, Packaging requirements for pesticides and devices.

g. Title 40 CFR, 1994 rev., Part 165, Regulations for the acceptance of certain pesticides and recommended procedures for the disposal and storage of pesticides and pesticides containers.

h. Title 40 CFR, 1994 rev., Part 165.10, Recommended procedures and criteria for storage of pesticides and pesticide containers.

2. DEPARTMENT OF DEFENSE

a. DOD Directive 4150.7, Pest Management Program.

b. Military Handbook (HDBK) 1028/8A, Design of Pest Management Facilities.

3. DEPARTMENT OF THE ARMY

a. AR 40-5, Preventive Medicine.

b. AR 40-12, Medical and agricultural foreign and domestic quarantine regulations for vessels, air craft, and other transports of armed forces.

c. AR 40-574, Aerial dispersal of pesticides.

d. AR 40-656, Veterinary Surveillance Inspection.

e. AR 200-1, Environmental Protection and Enhancement.

f. AR 200-2, Environmental Effects of Army Actions.

g. AR 200-10, Army Environmental Programs.

h. AR 385-10, Army Safety Programs.

i. AR 385-30, Safety Color Code Marking and Signs.

j. AR 385-32, Protective Clothing and Equipment.

k. AR 420-47, Solid Waste Management.

l. AR 420-74, Natural Resources - land, forest and wildlife.

m. AR 420-76, Pest Management.

o. AR 600-8-19, Enlisted Promotions and Reductions.

p. AR 608-10, Child Development Centers.

q. AR 670-1, Wear and Appearance of Army Uniforms and Insignia.

r. AR 700-93, Processing and shipping DOD sponsored retrograde material destined for shipment to the United States, its territories, trusts and possessions.

s. FM 8-33, Control of Communicable Diseases in Man.

t. FM 8-250, Preventive Medicine Specialist.

u. FM 21-10, Field Hygiene and Sanitation.

v. TM 5-629, Herbicide Manual.

w. TM 5-630, Natural Resources - Land Management.

x. TM 5-631, Natural Resources - Forest Management.

y. TM 5-632, Military entomology Operational Handbook.

z. TM 5-633, Natural Resources - Fish and Wildlife Management.

aa. TM 5-660, Backflow Devices.

bb. TM 5-635, Natural Resources - Outdoor Recreation and Cultural Values.

cc. SB 3-40, Department of the Army Supply Bulletin - Pesticides.

dd. TB MED 502, Occupational and Environmental Health, The Army Industrial Hygiene Program, February 1985.

ee. TB MED 506, Occupational and Environmental Health Occupational Vision, December 1981.

4. ARMED FORCES PEST MANAGEMENT BOARD TECHNICAL INFORMATION MEMORANDUMS (TIM)

a. TIM 5, Land Snails - Jun 1990.

b. TIM 11, Hydrogen Phosphide Fumigation with Aluminum Phosphide - Feb 1987.

c. TIM 13, Ultra Low Volume Dispersal of Insecticides by Ground Equipment - Mar 1985.

d. TIM 14, Personnel Protective Equipment for Pest Management Personnel - Mar 1992.

e. TIM 15, Pesticide Spill Prevention and Management - Jun 1992.

f. TIM 16, Pesticide Fires: Prevention, Control and Cleanup - Jun 1991.

g. TIM 17, Pest Control Facilities - Replaced by MIL-HDBK 1028/8A, 1 Nov 1991.

h. TIM 18, Installation Pest Management Program Guide - Feb 1987.

i. TIM 20, Pest Management in Health Care Facilities - Oct 1989.

j. TIM 21, Pesticide Disposal Guide for Pest Control Shops - Oct 1986.

k. TIM 22, Guidelines for Testing Experimental Pesticides on DOD Property - Nov 1983.

l. TIM 23, Schistosomiasis - Jan 1987.

m. TIM 24, Contingency Pest Management Pocket Guide - Sep 1991.

n. TIM 25, Devices for Electrocution of Flying Insects - Aug 1988.

o. TIM 26, Lyme Disease - Vector Surveillance and Control - Mar 1990.

p. TIM 27, Stored Products Pest Monitoring Techniques - Jun 1992.

q. TIM 31, Contingency Retrograde Washdowns: Cleaning & Inspection Procedures

5. MEDICAL COMMAND.

a. HSC Reg 11-4, HSC operating program - preventive medicine guidelines for implementation of a preventive medicine program for MEDDAC/MEDCEN.

b. HSC PAM 40-3, Environmental Health Program.

6. MILITARY STANDARDS

a. MIL-STD-903C, Sanitary Standards for Commissaries.

b. MIL-STD-904A, Guidelines for Detection, Evaluation, and Prevention of Pest Infestation of Subsistence.

c. MIL-STD-1432, Herbicides.

d. MIL-STD-1468B, In transit fumigation of freight cars.

7. CHPPM (USAEHA) TECHNICAL GUIDES

a. TG 26, Respiratory Protective Devices.

b. TG 100, DA pest resistance surveillance programs.

c. TG 101, Pesticide monitoring guidelines, scheduled monitoring.

d. TG 102, Guide for the conduct of installation pest surveillance programs.

e. TG 103, Plague surveillance guide.

f. TG 104, Guide to protective equipment for pest control personnel.

g. TG 105, Environmental sampling and evaluation on the investigation of alleged pesticide incidents.

h. TG 106, Guide for pest control operations in U.S. Army Medical Treatment Facilities.

i. TG 107, Guide to pesticides registered trade names.

j. TG 108, Guidelines for Installation Pest Management Program Surveys and Reviews.

k. TG 109, Guidelines for evaluating ground ULV insecticides dispersal.

l. TG 110, Ultra low Volume dispersal of insecticides by ground equipment (TIM 13).

m. TG 111, Evaluation for determination of comparative noise levels produced by selected ULV spray equipment.

n. TG 112, Evaluation of ultra-low volume spray equipment.

o. TG 113, Criteria for design of a pest control shop, pesticide storage and mixing facility.

p. TG 114, Guide for the Medical Surveillance of Pest Controllers.

q. TG 115, Pesticide monitoring guidelines, Department of the Army pesticide monitoring program.

r. TG 116, Guide for fish kill investigations.

s. TG 117, Pesticide fires.

t. TG 119, Collecting and shipping insects for resistance testing.

u. TG 124, Occupational Health Program Manual.

v. TG 125, The index of Occupational Health Education materials.

w. TG 128, Cockroach Surveillance Guide.

x. TG 141, Industrial Hygiene Sampling Instructions.

8. DEPARTMENT OF THE NAVY

a. Navy Medical Department Guide to Malaria Prevention and Control.

b. Pocket Guide to Pest Control.

c. Recommendations for chemical control of disease vectors and economic pests.

d. Vector control equipment performance checklist.

9. PERIODICALS

a. Common Sense Pest Control Quarterly. The Bio-Integral Resource Center (BIRC)- P.O. Box 7414, Berkeley, CA 94707. (415) 524-2567, FAX (415) 524-1758.

b. The IPM Practitioner. BIRC P.O. Box 7414, Berkeley, CA 94707. (415) 524-2567, FAX (415) 524-1758.

c. Pest Control. P.O. Box 6215, Duluth, MN 55806-9833

d. Pest Control Technology. 4012 Bridge Ave., Cleveland, OH 44113 (218) 961-4130, FAX (216) 961-0384.

e. Wing Beats of the American Mosquito Control Association. Florida Mosquito Control Assoc. AMCA, 707 East Prein Lake Rd., P.O. Box 5418, Lake Charles, LA 70606-5416. (318) 474-2723, FAX (318) 4789434.

10. GENERAL TEXTS

a. *Farm Chemicals Handbook 1992.* Maister Pub. Co. 37733 Euclid Ave.. Willoughby, OH 44094. (216) 942-2000, FAX (216) 942-0662. Published yearly.

b. Arnett, R.H. JR. and R.L. Jacques. 1981. *Guide to Insects.* Sandhill Crane Press, Inc., P.O. Box 147050, Gainesville, FL 32614-7050. (904) 375-6610, FAX (904) 331-4000.

c. Borror, D.J., D.M. Delong and C.A. Triplehorn. 1981. *An Introduction to the Study of Insects.* 5th Edition. New York: Macmillan. 548 pp.

d. Bottrell, D.R. 1979. *Integrated Pest Management.* Council on Environmental Quality, U.S. Government Printing Office, Washington D.C. 20402. 120 pp.

e. Flint, M.L. and R. van den Bosch. 1981. *Introduction to Integrated Pest Management.* Plenum Presa, 233 Spring St., New York, NY 10013, 240 pp.

f. Gorham, J.R. editor. 1991. *Ecology and Management of Food Industry Pests.* AOAC International. 2200 Wilson Blvd., Suite 400-P, Arlington, VA 22201-3301. 600 pp. ISBN 0-935584-45-5.

g. Gorham, J.R. editor. 1991. *Insect and Mite Pests in Food: An Illustrated Key.* U.S. Department of Agriculture. Agriculture Handbook no. 655, Stock No. 001-000-04566-1. Order from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; (202) 783-3238.

h. Johnson, W.T. and H.H. Lyon. 1991. *Insects that Feed on Trees and Shrubs.* Cornell University Press, 124 Roberts Place, P.O. Box 250, Ithaca, NY 14851-0250. 560 pp. (607) 277-2211

i. Marers P.J. 1988. *The Safe and Effective Use of Pesticides.* Univ. of CA Statewide IPM Project. Division of Agriculture and Natural Resources. Publication No. 3324. (415) 642-2431.

j. Olkowski, W., S. Dear and H. Olkowski. 1991. *Common Sense Peat Control.* Taunton Press. BIRC, P.O. Box 7414, Berkeley CA 94707.

k. Sinclair, W.A., H.H. Lyon and W.T. Johnson. 1991. *Diseases of Trees and Shrubs.* Cornell Univergity Press, 124 Roberts Place, P.O. Box 250, Ithaca. NY 14851-0250. 574 pp. (607) 277-2211.

l. Tashiro, H. 1991. *Turfgrass Insects of the United States and Canada.* Cornell University Press, 124 Roberta Place, P.O. Box 250, Ithaca, NY 14851-0250. 472 pp. (607) 277-2211.

m. Ware, G.W. 1986. *Fundamentals of Pesticides: A Self-instructional Guide.* Fresno CA: Thomson Publication. 274 pp.

n. Ware, O.W. 1987. *The Complete Guide to Pest Control: With and Without Chemicals.* Fresno CA: Thomson Publication. 290 pp.

11. MEDICAL TEXTS

a. Benenson, A.S. editor. 1990. *Control of Communicable Diseases in Man.* Fifteenth Edition. American Public Health Association, 1015 Fifteenth Street NW, Washington D.C. 20005.

b. Harwood, R.F. and M.T. Jameg. 1979. *Entomology in Human and Animal Health.* New York: Macmillan. 852 pp.

c. Last, J.M. editor. 1980. *Maxcy-Rosenaii Public Health and Preventive Medicine.* llth edition. New York: Appleton Century Crofts.

d. Strickland editor. 1991. *Hunter's Tropical Medicine.* 7th Edition. W.B. Saunders Publisher, 6277 Sea Harbor Dr., Orlando, FL 32821. Ph. 1-800-545-2522.

NOTE: **For Environmental Directories, Glossaries, Information Sources, Lists and Research Guides contact:**

Government Institutes. Inc
4 Research Place, Suite 200
Rockville, MD 20850
Phone (301) 921-2355

RECOMMENDED GENERAL REFERENCES OR PESTICIDE INFORMATION

U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), Aberdeen Proving Ground, Maryland 21010-5422

Pesticide Hot Line	DSN: 584-3773	Commercial (410) 671-3773
Routine Call	DSN: 584-3015/3792	

CHEMTREC	Toll Free	1-800-424-9300
	Overseas or Washington, D.C.	(202)483-7616

Poison Control Center
Your nearest center's telephone number is:_____

APPENDIX B: MAJOR COMMAND PEST MANAGEMENT CONSULTANTS

CONUS Command	DSN	Commercial
Forces Command (FORSCOM)	797-3157	404-362-3157
Training and Doctrine Command (TRADOC)	680-2366/3300	804-727-2366/3600
Defense Logistics Agency	284-9084/6124 (DLA)	703-274-9084/6124
Medical Command (MEDCOM)	471-7932	210-221-7932
Army Environmental Center		

OCONUS Command	
U.S. Army Europe (USAREUR)	49-06221-578125 ETS: 370-9073/8125
U.S. Army South (SOUTHCOM)	
U.S. Army Pacific Command (PACCOM)	

APPENDIX C: DOD PEST MANAGMENT CERTIFICATION COURSES

- **U.S. Army Medical Department Center and School (AMEDDC&S)**
  ATTN: MCCS-HPM
  Fort Sam Houston, TX 78234-6100
  DSN: 471-4278/5270, Commercial (210) 221-4278/5270

- **U.S. Navy Disease Vector Ecology and Control Center (DVECC)**
  Naval Air Station
  Box 43
  Jacksonville, FL 32212
  DSN: 942-2424, Commercial (904) 772-2424

- **U.S. Navy Disease Vector Ecology and Control Center (DVECC)**
  Naval Air Station
  Box 130
  Alameda, CA 94501-5039
  DSN: 993-2806, Commercial (510) 263-2806

- **U.S. Air Force**
  Sheppard AFB, TX
  DSN: 736-5785, Commercial (871) 676-57856
  [for a seat at Sheppard AFB Courses, Call Programs Division at Randolph AFB, TX, at DSN 487-3043 or Commercial (512)652-3043]

- **Aerial Spray Certification**
  757 AS/DOSE, YARS
  Vienna, OH 44473-5000
  DSN 346-1513/1111, Commercial (216)392-1111

APPENDIX D: ADDRESS FOR MILITARY PUBLICATIONS PERTINENT TO PEST MANAGEMENT

- **Technical Information Bulletin published every two months by:**

  Defense Pest Management Information Analysis Center (DPMIAC)
  Armed Forces Pest Management Board (AFPMB)
  Forest Glen Section, WRAMC
  Washington, D.C. 20307-5001
  DSN: 291-5365, Commercial (202) 427-5365

- **Pest Management Bulletin published periodically by:**

  Commander, CHPPM
  ATTN: HSHB-MR-EMO (Pest Management Bulletin)
  Aberdeen Proving Ground, MD 21010-5422
  DSN: 584-3773, Commercial (410) 671-3773

- **Gotcha, an unscheduled publication by:**

  Northern Division
  Naval Facilities Engineering Command
  10 Industrial Highway -- Mail Stop 82
  Lester, PA 19113-2090
  DSN: 443-0556, Commercial (215) 595-0556

APPENDIX E: APPENDIX OF ACRONYMS

*** A ***

AEHA	.....	Army Environmental Hygiene Agency
AFPMB	.....	Armed Forces Pest Management Board
APHIS	.....	Animal and Plant Health Inspection Service
AR	.....	Army Regulation
AWPA	.....	American Wood Preservers Association

*** C ***

CDC	.....	Centers for Disease Control
CERCLA	.....	Comprehensive Environmental Response Compensation and Liability Act
CHPPM	.....	Center for Health Promotion and Preventive Medicine
CONUS	.....	Continental United States
CWA	.....	Clean Water Act

*** D ***

DA	.....	Department of the Army
DE	.....	District Engineer
DEH	.....	Directorate of Engineering and Housing
DERA	.....	Defense Environmental Restoration Act
DoD	.....	Department of Defense
DPW	.....	Directorate of Public Works
DRMO	.....	Defense Reutilization and Marketing Office

*** E ***

EA	.....	Environmental Assessment
EC	.....	Emulsifiable Concentrate
ECAS	.....	Environmental Compliance Assessment
EIS	.....	Environmental Impact System
EPA	.....	Environmental Protection Agency
EPW	.....	Enemy Prisoner of War
ESA	.....	Endangered Species Act

* F *

FEPCA	.....	Federal Environmental Pesticide Control Act
FIFRA	.....	Federal Insecticide, Fungicide, and Rodenticide Act

* G *

GAP	.....	Government Agency Plan
GOCO	.....	Government Owned, Contract Operated
GPM	.....	Gallons Per Minute
GSA	.....	General Services Administration

* H *

HQDA	.....	Headquarters, Department of the Army

* I *

IAW	.....	In Accordance With
IGR	.....	Immature Growth Regulator
IPM	.....	Integrated Pest Management
IPMC	.....	Integrated Pest Management Coordinator
IPMP	.....	Installation Pest Management Plan
ISCP	.....	Installation Spill Contingency Plan

* J *

JAG	.....	Judge Advocate General
JH	.....	Juvenile Hormone

* M *

MACOM	.....	Major Command
MEDDAC	.....	Medical Activity
MIL STD	.....	Military Standard
MSDS	.....	Medical Safety Data Sheet

*** N ***

NEHC	. . . . .	Navy Environmental Health Center
NEPA	. . . . .	National Environmental Policy Act
NSN	. . . . .	National Stock Number

*** O ***

OCONUS	. . . . .	Outside the Continental United States
OSD	. . . . .	Office of the Secretary of Defense
OSHA	. . . . .	Occupational Safety and Health Act

*** P ***

PAO	. . . . .	Public Affairs Office
PDB	. . . . .	Paradichlorobenzene
PMC	. . . . .	Pest Management Coordinator
PPM	. . . . .	Parts Per Million
PSI	. . . . .	Pounds Per Square Inch
PVNTMED	. . . . .	Preventive Medicine

*** R ***

RCRA	. . . . .	Resource Conservation and Recovery Act

*** S ***

SOFA	. . . . .	Status of Forces Agreement
SOP	. . . . .	Standing Operating Procedure
SP	. . . . .	Soluble Powder
SPCC	. . . . .	Spill Control and Counter Measures

*** T ***

TSCA	. . . . .	Toxic Substances Act
TB MED	. . . . .	Technical Bulletin Medical
TIM	. . . . .	Technical Information Manual
TG	. . . . .	Technical Guide
TM	. . . . .	Technical Manual

* U *

UIC	.....	Unit of Issue Code
ULD	.....	Ultra Low Dosage
ULV	.....	Ultra Low Volume
USACE	.....	US Army Corp of Engineers
USATHAMA	.....	US Army Toxic and Hazardous Material Agency
USDA	.....	US Department of Agriculture

* W *

W	.....	Wetable Powder (also WP or WWP)
WP	.....	Wetable Powder (also W or WWP)
WS	.....	Water Soluble Concentrate
WWP	.....	Water Wetable Powder (also W or WP)

* Z *

APPENDIX F: SOLUTIONS TO LESSON EXERCISES

SOLUTIONS TO EXERCISES, LESSON 1

1. The FIFRA plus its amendments is designed to provide for registration of pesticides and post-market surveillance of pesticides and pesticidal devices to ensure prevention of unreasonable adverse effects upon human health or the environment. (para 1-4)

2. That a pesticide generally causes unreasonable adverse effects on the environment. (para 1-12)

3. You are correct if you listed any four of the following:

   - DDT.
   - Aldrin.
   - Dieldrin.
   - Some mercury pesticides.
   - Certain predator poisons used primarily for coyote control.

   (para 1-14)

4. DoD Directive 4150.7-P. (para 1-19)

5. The objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. (para 1-20)

6. a. Prohibit discharge of toxic pollutants in toxic amounts.

   b. Conduct major research and demonstrate major effort to develop technology needed to eliminate the discharge of pollutants into navigable waters, waters of the contiguous zone, and the oceans.

   c. Develop and implement programs in an expeditious manner for the control of nonpoint sources of pollution. (para 1-21)

7. a. Spill Prevention Control and Counter Measures plan.

   b. Installation Spill Contingency Plan. (para 1-23)

8. a. Provide for liability, compensation, cleanup, and emergency response of hazardous substances released into the environment.

   b. Provide for cleanup of inactive hazardous waste disposal sites. (para 1-24)

9. They are responsible for identifying the current habitat or range of each endangered species. (para 1-26)

10. The purpose of OSHA is to provide for safe and healthful working conditions for every working man and woman in the United States. (para 1-31)

11. Regulate chemicals used in commerce. (para 1-34)

12. AR-420-76. Facilities Engineering Pest Management. (para 1-37)

13. The installation facilities engineers. (para 1-37b)

14. The medical authority, Preventive Medicine Service. (para 1-37c)

15. a. AR 200-1
    b. Environmental Protection and Enhancement.

    (para 1-38a)

16. Integrating environmental considerations into Army planning and decision making. (para 1-39)

17. AR 40-5, Preventive Medicine. (para 1-40)

18. 50 (para 1-41)

SOLUTIONS TO EXERCISES, LESSON 2

1. DD Form 1532-1, Pest Management Maintenance Record. (para 2-3a)

2. DD Form 1532. Pest Management Report. (para 2-3b)

3. a. Safety considerations.
   b. Documentation of work accomplished.
   c. Forecast future work needs.
   d. Army-wide pesticide monitoring program.
   e. Pesticide misuse.
   f. Pesticide inventory.
   (para 2-4a through f)

4. Medical authority. (para 2-6b)

5. Adjust and improve the installation pest management plan. (para 2-7c)

SOLUTIONS TO EXERCISES, LESSON 3

1. The policy of DoD is to establish and maintain safe, efficient, and environmentally sound IPM programs to prevent or control pests that may adversely affect health or damage structures, materials, or property. (para 3-19)

2. The DoD definition of IPM is the use of all appropriate technological and management techniques to bring about an effective degree of pest prevention and suppression in a safe, cost-effective, environmentally sound manner. (para 3-6)

3. a. Biological control.
   b. Mechanical control.
   c. Physical control.
   d. Regulatory control.
   e. Cultural control.
   f. Chemical control.
   (para 3-7a, BOX)

4. a. Pesticide resistance.
   b. Destruction of natural controls.
   c. Environmental contamination.
   d. Health hazards.
   (para 3-2b)

5. Biological. (para 3-8a(2))

6. a. Irradiation.
   b. Return of the predator.
   c. Species specific pathogen.
   d. Insect growth regulators.
   e. Pheromone traps.
   (para 3-8b(1) through (5))

7. Mechanical. (para 3-9)

8. Physical. (para 3-10)

9. Cultural pest control is the careful nonchemical changing of the environment to make the environment less favorable for a particular pest. (para 3-12a)

10. Chemical control of a pest management problem would be considered after the problem had been carefully examined and other means of control eliminated. (para 3-13, BOX)

11. You are correct if you listed any five of the following:

- Gathering of data.
- Monitoring.
- Establishing threshold levels.
- Precise record keeping.
- Determining the least toxic treatments.
- Continued monitoring and evaluation.
- Education.

(para 3-17)

12. The solution is to educate the individual on other measure to take to reduce their personal pest annoyance factor. (para 3-16d(2))

SOLUTIONS FOR EXERCISES, LESSON 4

1. AR 420-76, Pest Management. (para 4-1)

2. Pest Management Program (IPMP). (para 4-1)

3. MACOM Pest Management Consultant (PMC) (para 4-3a(2))

4. Engineering and Housing (DEH). Public Works (DPW). (para 4-3c)

5. a. Control of disease vectors and reservoirs of medical importance.

   b. Control of pests that damage or destroy stored products; control of pests that damage or destroy beneficial products.

   c. Control of undesirable plants. (para 4-4)

6. a. Control disease vectors and reservoirs of medical importance.

   b. Control stored products pests.

   c. Control pests that damage and destroy beneficial plants. (para 4-10, BOX)

SOLUTIONS TO EXERCISES, LESSON 5

1. *Aedes.*
   Aegypti. (para 5-3b)

2. a. Exoskeleton rigidity.
   b. Muscle attachments.
   c. Shield internal organs. (para 5-4)

3. Desiccation and toxic chemicals. (para 5-4)

4. Mandibles. (para 5-5a)

5. a. Chewing mouthparts. (para 5-5a(1))

6. Labellum. (para 5-5a(2))

7. a. TRUE. (para 5-6)

8. Aemetamorphosis or no metamorphosis. (para 5-8b)

9. a. Egg.
   b. Larva.
   c. Pupa.
   d. Adult. (para 5-8e)

10. b. FALSE. (para 5-11)

11. Two. (para 5-13)

SOLUTIONS TO EXERCISES, LESSON 6

1. You are correct if you listed any of the following:

   - Beavers.
   - Groundhogs.
   - Woodchucks.
   - Rabbits.
   - Hares.
   - Coyotes.
   - Wolves.
   - Dogs.
   - Opossums.
   - Raccoons.
   - Skunks.
   - Feral cats.
   - Deer.
   - Elk.
   - Moose.
   - Sea gulls.
   - Pigeons.
   - Waterfowl.
   - Snakes.

   (paras 6-3 through 6-7)

2. Beaver. (para 6-3a)

3. a. Coyotes.
   b. Wolves.
   c. Dogs.
   (para 6-4a(1))

4. Rabies. (para 6-4d(1))

5. Property damage.
   Health hazard. (para 6-6b(1))

6. You are correct if you listed any four of the following:

   - Ornithosis.
   - Encephalitides.
   - Cryptococcoses.
   - Toxoplasmosis.
   - Histoplasmosis.
   - Salmonellosis.
   - Coccidiosis.

   (para 6-6b(1))

7. Snakes. (para 6-7b(1))

8. a. Fumigants.
   b. Conibear traps.
   c. Leg hold traps.
   d. Strychnine-treated bait.
   (para 6-3b(2))

9. a. Fencing.
   b. Den hunting.
   c. Snares.
   d. Leg hold traps.
   (para 6-4a(2))

10. You are correct if you listed any three of the following:

    - Mechanical frightening devices.
    - Toxic bait.
    - Toxic perches.
    - Traps.
    - Proofing and screening.
    - Chemical frightening agents.

    (para 6-6b(2))

11. Migratory Bird Treaty.
    (para 6-6f)

12. Stress the beneficial nature of snakes and bats as well as the nature of the threat.
    (para 6-10a)

SOLUTIONS TO EXERCISES, LESSON 7

1. a. Surveillance of pest populations.
   b. Evaluation of survey results.
   c. Selection of measures to manage the pest.
   d. Pest management (control) measures.
   e. Reevaluation.
   (para 7-2a through e)

2. a. Pest surveillance.
   b. Post-treatment surveillance.
   c. Pest management records.
   (para 7-3a through c)

3. The surveillance of medically important pests on military installations.
   (para 7-4a)

4. Pest management.
Pesticides.
(para 7-4b)

5. The MACOM entomologist.
(para 7-4c)

6. a. Determine that there is a pest problem.
b. Determine the pretreatment level of pest infestation.
c. Determine an appropriate type of pest control measure.
(para 7-3a)

7. Post-treatment surveillance documents the efficacy of a pest control effort.
(para 7-3b)

8. You are correct if you listed any two of the following responses:

- These records provide the historical data for each pest control site.
- The records provide information for workload forecasting.
- Document pesticide use in case of accidents or allegations of pesticide misuse.

(para 7-3c)

SOLUTIONS TO EXERCISES, LESSON 8

1. d
2. i
3. f
4. a
5. h
6. b
7. g
8. c
9. e

for 1 through 9:
(paras 8-3a, 8-4, 8-6a, 8-7a, 8-8a, 8-9, 8-10, 8-11, 8-12)

10. a. Groundwater is the water below the earth's surface, water which occupies the saturated zone.
(para 8-13a)

b. All the pore spaces in the rock or soil are filled with water.
(para 8-13a)

c. The upper level of the water-saturated zone.
(para 8-13b)

d. Water that seeps through the soil from rain, melting snow, or irrigation.
(para 8-13b)

e. When the rate at which pollutant materials entering waterbodies or groundwater exceeds natural levels.
(para 8-13c)

f. (1) Inadequate handling of livestock waste storage facilities.

(2) Unacceptable levels of nitrates from fertilizers in groundwater.
(para 8-13d)

11. You are correct if you listed any five of the following;

- Use integrated pest management programs.
- Consider the geology of your area.
- Consider the soil characteristics.
- Select pesticides carefully.
- Follow the label directions.
- Calibrate accurately.
- Measure accurately.
- Avoid back-siphoning.
- Consider weather and irrigation.
- Spills: avoid, contain, clean up.
- Select safe mixing areas.
- Dispose of wastes properly.
- Store pesticides away from water sources.

(para 8-15a through m)

12. a. Dusts.
b. Wettable powders.
c. Microencapsulated insecticides.
(para 8-17b(2))

13. Insecticides are highly toxic to honeybees and wild bees. (para 8-17a)

14. a. Use no pesticides during bloom.
    b. Select the least harmful formulations to use around bees.
    c. Reduce drift.
    d. Select an appropriate time to use pesticides.
    e. DO NOT spray near bee hives.
    (para 8-17b(1) through (5))

SOLUTIONS TO EXERCISES, LESSON 9

1. a. Skin
   b. Lungs.
   c. Mouth. (para 9-3)

2. Subjecting test animals to different dosages of an active ingredient and to each of its formulated products. (para 9-7)

3. The capacity of a pesticide to cause injury from a single exposure. (para 9-8a)

4. LD50 (lethal dose 50). (para 9-8b)

5. Compare the toxicity of different active ingredients as well as different formulations of the same active ingredient. (para 9-8c)

6. The toxicity of a pesticide. (para 9-9a)

7. The ability of a pesticide to cause injury from repeated, prolonged exposure to small amounts of pesticides. (para 9-10a)

8. You are correct if you listed any four of the following:

   - Birth defects.
   - Toxicity to a fetus.
   - Production of tumors.
   - Genetic changes.
   - Blood disorders.
   - Nerve disorders.
   - Fertility effects.

   (para 9-10b)

9. a. Particular herbicide or fungicide.
   b. Amount absorbed.
   c. General health of the individual.
   (para 9-17a)

10. Get him to fresh air immediately. (para 9-22b)

11. Dermal. (para 9-22a)

SOLUTIONS TO EXERCISES, LESSON 10

1. a. The group of pests managed by the pesticide.
   b. How the pesticide works.
   c. The chemical nature of the pesticide.
   d. The pesticide formulation.
   (para 10-2)

2. When pesticide mixtures cause injury to plants sprayed with the mixture. (para 10-31)

3. You are correct if you listed any three of the following:

   - Fumigants act as separate molecules.
   - Molecules penetrate the material being fumigated and leave when finished.
   - No residue is left to contaminate food.
   - The procedure is quick and there is total pest kill.

   (para 10-25c)

4. a. Minerals.
   b. Man made.
   c. Organic pesticides.
   (paras 10-5a through 10-6a)

5. c.
6. a.
7 d. for 5 through 10
8 b. (figure 10-1)
8 f.
10 e.

11. f.
12. d.
13. a. for 11 through 16
14. c. (para 10-4a through f)
15. e.
16. b.

SOLUTIONS TO EXERCISES, LESSON 11

1. Label. (para 11-1)

2. Brand. (para 11-2b)

3. Trade. (para 11-2a)

4. False. (para 11-16a(2), BOX)

5. d (para 11-3b)

6. i (para 11-14a)

7. j (para 11-11b)

8. g (para 11-8)

9. a (para 11-10b)

10. h (para 11-12)

11. e (para 11-13b)

12. b (para 11-7)

13. c (para 11-3a)

14. f (para 11-4)

SOLUTIONS TO EXERCISES, LESSON 12

1. Those items could become contaminated and poison you when you use them. (para 12-1b)

2. Rubber boots. (para 12-2b)

3. Clean a face shield with gentle soap and water. Then, air dry the face shield. (para 12-2e)

4. Noisy. (para 12-2h)

5. Read the label and follow all the instructions. (para 12-3h)

6. Detergent and water and air-dried. (para 12-2d)

7. a. T (para 12-4)
   b. T (para 12-5a)
   c. F (para 12-5b)
   d. T (para 12-5c)
   e. F (para 12-5e)

8. a. The shop.
   b. Fire department.
   c. Safety officer.
   d. Other base activity. (para 12-8a)

9. Such contaminated materials must be removed and placed in a sealed leakproof drum. Label the drum properly and dispose of it in a hazardous waste disposal facility. (para 12-19)

SOLUTIONS TO EXERCISES, LESSON 13

1. You are correct if you listed any three of the following:

   - Types of pests.
   - Type of area/surface.
   - Condition of application site.
   - Availability of equipment/materials.
   - Type of formulations available.

   (paras 13-2 through 13-6)

2. The application of pesticide to surfaces where pests may feed, rest, or crawl. (para 13-7)

3. Spot treatment. (para 13-7c)

4. Spreading it over a large area where pests live. (para 13-7c)

5. Larger than 400 microns. (para 13-13a)

6. a. Eradication.
   b. Suppression.
   c. Prevention. (Section V)

7. ... between 40°F and 85°F ... higher ... 10. (para 3-10c)

8. a. Pesticide drifts.
   b. Pesticide does not adhere to surfaces.
   (para 13-11b)

9. Granules and pellets. (para 13-13c)

10. Hollow cone. (para 13-16)

SOLUTIONS TO EXERCISES, LESSON 14

1. a. Broadcast applications.
   b. Direct spray applications.
   c. Spot treatments.
   d. Injection.
   e. Crack and crevice treatments.
   (para 14-2b, BOX)

2. a. Dining facilities.
   b. Small jobs such as spot treatments.
   (para 14-3a)

3. Air blast sprayer. (para 14-3d)

4. Backpack sprayer. (para 14-3g)

5. Weeds growing taller than the crop. (para 14-4)

6. a. This equipment minimizes drift.
   b. The equipment eliminates mixing of chemicals. (para 14-5a)

7. a. Greenhouses and enclosed rooms.
   b. Pesticide is carried in the smoke.
   (para 14-6a)

8. You are correct if you listed any three of the following:

   - Solid stream nozzle.
   - Flat fan nozzle.
   - Hollow cone nozzle.
   - Solid cone nozzle.
   - Atomizing nozzle.
   - Broadcast nozzle.
   - Rotary nozzle.

   (para 14-12a through g)

9. a. Foams.
   b. Invert emulsions.
   c. Thickeners.
   (para 14-21a through c)

10. Thickeners. (para 14-21c)

SOLUTIONS TO EXERCISES, LESSON 15

1. Ensuring that the correct amount of pesticide is applied over a specified area. (para 15-1a)

2. You are correct if you listed any three of the following:

   - Effective control.
   - Money saved.
   - Reduced risk of phytotoxicity.
   - Avoidance of legal liability.
   - Safety. (para 15-1b)

3. 9.3 divided by (1000 times 10) times 10,890 = 10.13 gallons/acre. (para 15-8)

4. Decrease the tractor speed; replace the nozzles with nozzles having a large orifice; or increase the pump pressure. (para 15-9)

SOLUTIONS TO EXERCISES, LESSON 16

Solutions are located on page 16-20.

STUDENT COMMENT SHEET

Subcourse number, title, course date: MD0141, Department of Defense Pest Management Course, CORE -- 1997

Today's date: _____

Errors in subcourse: _____

Suggested changes in subcourse: _____

Student rank & name »» _____

Social security number »» _____

Street address »» _____

City, state, ZIP »» _____

THANK YOU!

MAIL THIS STUDENT COMMENT SHEET TO:

ACADEMY OF HEALTH SCIENCES
ATTN: MCCS-HPM
3151 SCOTT ROAD STE 1138
FORT SAM HOUSTON, TEXAS 78234-6142

PRIVACY ACT STATEMENT (AUTHORITY: 10USC3012(B) AND (G))

PURPOSE: To provide this the students of this program wil a means to submit inquiries and comments.
USES: To make necessary changes to student records.
DISCLOSURE VOLUNTARY: Failure to submit SSN may prevent response to inquiries which require follow-ups.